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PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—IX

NORTH AMERICAN SPECIES OF DISCINA

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(WITH PLATE 4)

The genus *Discina* was established by Fries in 1849 as a monotypic genus, having been segregated from the old genus *Peziza* and based on *Peziza perlata* of Fries which, so far as we can see, is identical with *Peziza ancilis* of Persoon. The species is characterized by the thick waxy consistency and the expanded form of the apothecia. The spores of the species also furnish important diagnostic characters, although these were not mentioned by Fries when the genus was proposed. The spores are unusually large, strongly roughened at maturity, and provided with an apiculate appendage at either end.

Although the genus originally contained a single species, it has been gradually enlarged until at present it contains a score or more of species. In fact, almost every species which shows a tendency to become repand or flattened has finally come to be placed in the genus *Discina*.

After an extended study the writer, while recognizing the genus, is inclined to use it in a more restricted sense to include those large forms of cup-fungi which have appendiculate spores since the spore characters are more fixed and reliable than the mere form of the apothecia which is so susceptible to change. The genus would then include comparatively few but well marked species.

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The type species, *Discina ancilis*, a large and conspicuous fungus, is frequently collected from New York State west to Washington. A number of specimens have been received from J. R. Weir to whom the writer is indebted for the accompanying photograph. *Peziza Warnei* was described by C. H. Peck from material collected at Oneida, New York, by H. A. Warne. Examination of some of this material in the herbarium of the New York Botanical Garden shows it to be identical with *Discina ancilis*.

Discina leucoxantha is also a large and attractive species but is less frequently collected. It is readily recognized by its light color and by the truncate appendages which mark the spores. Several specimens have been received from Stewart H. Burnham, collected at Hudson Falls, New York. Other specimens from New York and Maryland have been examined. *Discina convoluta* differs in its extremely convolute hymenium. Whether this character is constant must be determined by future collections.

Peziza apiculate of Cooke also doubtless belongs to *Discina* as here treated although the occurrence of this species in North America is somewhat doubtful. A very small specimen collected by B. O. Dodge in Bermuda has been doubtfully referred to this species. Also *Peziza elacodes* of Clements seems to agree although no specimen has been seen. Doubtless other apiculate spored species of cup-fungi occur in North America and it is hoped that more will come to light. A synopsis of the North American species follows:

37. *DISCINA* Fries, Summa Veg. Scand. 348. 1849

Apothecia medium to large, sessile or short-stipitate, fleshy or waxy, light or dark-colored; asci cylindric or subcylindric, very long, usually showing a tendency to become spirally twisted; spores ellipsoid, appendiculate and often sculptured, hyaline or faintly colored; spore appendages apiculate or truncate; paraphyses rather stout.

Type species, *Discina perlata* Fries.

Apothecia dark-colored; spore appendages apiculate.

Apothecia large, 6-7 cm. or more in diameter.

1. *D. ancilis*.

Apothecia medium sized, not exceeding 1.5 cm. in diameter.

2. *D. apiculata*.

Apothecia bright-colored; spore appendages truncate.

Hymenium strongly convolute.

3. *D. convoluta*.

Hymenium even or only slightly undulated.

4. *D. leucoxantha*.

I. DISCINA ANCILIS (Pers.) Sacc. Syll. Fung. 8: 103. 1899

Peziza ancilis Pers. Myc. Eu. 1: 219. 1822.

Peziza perlata Fries, Syst. Myc. 2: 43. 1822.

Discina perlata Fries, Summa Veg. Scand. 348. 1849.

Rhizina helvetica Fuckel, Symb. Myc. Nacht. 2: 66. 1873.

Peziza Warnei Peck, Ann. Rep. N. Y. State Mus. 30: 59. 1878.

Aleuria ancilis Gill. Champ. Fr. Discom. 36. 1879.

Acetabula ancilis Lamb. Fl. Myc. Belg. 2: 573. 1880.

Discina Warnei Sacc. Syll. Fung. 8: 102. 1889.

Discina ancilis Sacc. Syll. Fung. 8: 103. 1889.

Discina helvetica Sacc. Syll. Fung. 8: 103. 1889.

Apothecia gregarious or scattered, more rarely congested, short-stipitate, at first subglobose, soon becoming discoid, finally repand, at first regular in form, becoming irregular and often angular as the margin rolls back, externally whitish or pallid, reaching a diameter of 7 or 8 cm., or in rare cases as large as 20–25 cm.; hymenium uneven, often beautifully veined or convolute, plane or convex, usually umbilicate, dark-brown, finally almost black; stem very short and stout, often 1–3 cm. in diameter and rarely exceeding 1 cm. in length, or entirely wanting, more or less lacunose, whitish or overcast with a pinkish tint; asci cylindric or subcylindric, reaching a length of 300–350 μ and a diameter of 12–18 μ , 8-spored; spores obliquely 1-seriate, very large, ellipsoid, hyaline, 12–14 \times 30–35 μ , or occasionally as long as 40 μ including apiculi; at first smooth, becoming sculptured; spore-sculpturing consisting of minute warts; spore appendages consisting of a minute apiculus 4–5 μ long and 3–4 μ broad at the base, one at either end of the spore; paraphyses strongly enlarged above, closely adhering together, dark yellowish-brown, reaching a diameter of 8 μ .

On the ground in coniferous woods, more rarely on rotten wood.

TYPE LOCALITY: Europe.

DISTRIBUTION: New York to Washington, Oregon, and Colorado; also in Europe.

ILLUSTRATIONS: Ann. Rep. N. Y. State Mus. 30: pl. 1, f. 19–21; Boud. Ic. Myc. pl. 252; Fuckel, Symb. Myc. Nacht. 2:

f. 24; Pat. Tab. Fung. f. 596; Cooke, Mycographia pl. 103, f. 371; Rab. Krypt.-Fl. 1^o: 922, f. 1-4.

EXSICCATI: Shear, New York Fungi 324: N. Am. Fungi 2622.

2. *Discina apiculata* (Cooke) Seaver, comb. nov.

Peziza apiculata Cooke, Mycographia 175. 1877.

Phaeopezia apiculata Sacc. Bot. Centr. 18: 218. 1884.

Aleuria apiculata Boud. Hist. Class. Discom. Eu. 47. 1907.

? *Peziza elaeodes* Clements, Bot. Surv. Nebr. 5: 6. 1901.

Apothecia scattered, sessile, at first cup-shaped, soon becoming discoid, fleshy, circular in outline not usually exceeding 1.5 cm. in diameter; hymenium dark brownish-black, slightly concave or nearly plane; asci cylindric or subcylindric, reaching a length of 200 μ and a diameter of 18 μ , 8-spored; spores obliquely 1-seriate, with the ends overlapping, narrow-ellipsoid to fusoid, often with a small apiculus at either end, becoming pale brownish and often delicately sculptured, about 10 \times 24 μ , containing two large oil-drops; spore sculpturing consisting of minute warts; paraphyses slender, adhering together at their apices, dark-brown.

On damp soil.

TYPE LOCALITY: Italy.

DISTRIBUTION: (Nebraska?) and (Bermuda?); also in Europe.

ILLUSTRATIONS: Cooke, Mycographia pl. 79, f. 305.

3. *Discina convoluta* Seaver, sp. nov.

Apothecia gregarious or cespitose, very short-stipitata, becoming shallow cup-shaped or subdiscoid, externally whitish at the base, becoming yellowish upwards toward the margin, reaching a diameter of 6 cm.; hymenium yellowish-brown, very deeply convolute, the convolutions consisting of more or less radiating ribs or veins, resembling those of *Peziza venosa* but more distinct; stem very short and stout, 1 cm. or more thick and usually not more than 1 cm. long, whitish, deeply corrugated; asci cylindric or subcylindric, reaching a length of 400-500 μ and a diameter of 20 μ , 8-spored but a part of the spores often remaining undeveloped; spores 1-seriate, with the ends usually overlapping, ellipsoid, becoming sculptured and appendiculate, 12-14 \times 35-40 μ ; spore-sculpturing consisting of warts or short interrupted ridges which often approach very fine reticulations; spore appendages consisting of a cup-like structure at each end; paraphyses stout, usually straight, reaching a diameter of 8 μ at their apices, densely filled with yellow granules.

On the ground in woods.

Type collected in the woods near Yonkers, New York, May 22, 1916, by F. J. Seaver.

DISTRIBUTION: Known only from the type locality.

4. *DISCINA LEUCOXANTHA* Bres. Rev. Myc. 4: 212. 1882

Peziza leucoxantha Bres. Fungi Trid. 42. 1881.

Apothecia gregarious or substipitate, at first subglobose, expanding and becoming hemispheric or nearly plane, externally whitish, reaching a diameter of 4-7 cm., the margin regular or lobed; hymenium concave or nearly plane, even or undulated, bright-yellow or becoming yellowish-brown with age; stem about 1 cm. in diameter and scarcely exceeding 5 mm. in length, irregularly corrugated at the base, the flesh thick and brittle; asci cylindric or subcylindric, attenuated at the base, reaching a length of 400μ and a diameter of 20μ , becoming twisted, 8-spored; spores ellipsoid, smooth, containing one large oil-drop and several smaller ones, becoming minutely sculptured, $10-15 \times 27-35\mu$; spore-sculpturing consisting of minute warts or occasionally minute ridges or indistinct reticulations; spore appendages consisting of truncate protuberances, one at either end of the spore; paraphyses slender, septate, branched, slightly enlarged above, filled with orange granules.

On the ground in coniferous woods.

TYPE LOCALITY: France.

DISTRIBUTION: New York; also in Europe.

ILLUSTRATIONS: Bres. Fungi Trid. pl. 44; Bull. Soc. Myc. Fr.

3: pl. 12; Boud. Ic. Myc. pl. 253; Rab. Krypt.-Fl. 1^a: 922. f. 5.

NEW YORK BOTANICAL GARDEN.

DESCRIPTION OF PLATE 4

1. *Discina convoluta* Seaver. Two plants about natural size with drawings of a portion of an ascus with spores, paraphysis, and one spore isolated.

2. *Discina ancilis* (Pers.) Sacc. One plant showing the hymenial surface and one in profile both about natural size with drawing of a portion of an ascus with spores and paraphysis.

All drawings made with the aid of the camera lucida.

MASSOSPORA CICADINA PECK

A Fungous Parasite of the Periodical Cicada

A. T. SPEARE

(WITH PLATES 5 AND 6)

Among the enemies of the periodical cicada, *Tibicina septendecim* (L.), none perhaps is of more interest than the fungus *Massospora cicadina*. It is of interest because to perpetuate itself upon a host of such extraordinary life habits, and so far as is known it occurs on no other host, it must likewise possess a very unusual mode of life. It is of interest also because its relationship to other entomogenous fungi has not been clearly understood up to the present time, and, like many other entomogenous forms, it is worthy of especial consideration because it attacks an insect of some economic importance.

Although the organism was apparently first observed by Leidy (1850), the first description of it was published by Peck (1879). It seems probable that Peck observed the resting spores of the fungus as well as its conidia, but apparently he did not observe the processes associated with the formation of either of these types of reproductive bodies, and, lacking the information that a study of such stages would have afforded him, the organism was erroneously placed near *Protomyces* among the *Coniomycetes*. Thaxter (1888) almost simultaneously with Forbes (1888), published a brief note in which the fungus was considered as a member of the Entomophthorales, but as only a few old dried specimens were available for study at the time, none of which showed the resting spores, he apparently did not feel fully justified in assigning it to this family of fungi.

In addition to the above mentioned papers, several others have appeared such as those of Butler (1886) and Marlatt (1907), in which the gross appearance of the fungus and of the diseased cicadas was briefly described, but with the exception of the above

mentioned brief note of Thaxter no other publication has appeared, as far as the writer is aware, in which the microscopic characters of the fungus have been considered.

Like the host which it parasitizes, *Massospora cicadina* is, so far as is known, peculiar to America, and as a result, Europeans, to whom the fungus is known only by such fragmentary and incomplete references as those noted above, have been more or less confused in regard to the nature of the organism, Lakon (1919a), for example, classing it with *Sorospora agrotidis* Sor. (*Sorospora uvella* (Krass.) Gd.) and *Massospora staritzii* Bresadola as "Unvollkommen bekannte Entomophthoreen bezw. als solche beschriebene Pilze."

During the summer of 1919, Brood X of the periodical cicada made its appearance in the vicinity of Washington, D. C., and an excellent opportunity was thus afforded the writer to study its fungous parasite. The later was first observed on May 31, about ten days after the first insects emerged from the earth, and from this date until the disappearance of the brood in the early part of July it was constantly present, though in no great abundance until after June 10.

The resting spore as well as the conidial condition of the fungus was common about Washington, in 1919, but the latter was never as abundant as the former, and while it was often a difficult matter to collect during an afternoon a dozen cicadas showing conidia, during as many hours later in the season it was not difficult to collect hundreds of specimens showing the resting spores. It should be noted, that both types of reproductive bodies were never found either simultaneously or consecutively in the same individual, and it was determined that the conidia and the resting spores occurred at different periods in the aerial life of the host, the former appearing exclusively in the early part of the season, the latter developing toward the end of the aerial existence of the insect. It should be noted furthermore that the fungus seemed to be largely though not exclusively confined to the male insects. Despite the fact that infected insects were observed and collected many times during the season, not more than half a dozen parasitized females were observed. Whether or not the

disproportionately large numbers of infected male individuals indicates a predisposition of the latter to attack by *Massospora cicadina* has not been determined but the present instance is not the only one of the kind for Giard (1888) records the same phenomenon in connection with a fungus upon *Tipula paludosa*, which he appropriately called *Entomophthora arrenoctona*.¹ Nevertheless it is a rather unusual condition and one that has not yet been satisfactorily explained. Not only is present fungus largely confined to male insects but in the resting spore condition at least, it seems furthermore, to parasitize spent individuals in most instances. In the closing days of the brood, when the females were busy ovipositing in the tree tops, it was observed that simultaneously, the males occurred by hundreds, either dead upon the ground, or alive and feebly attempting to crawl from the ground up the trunks of trees. A very large percentage of such males were found upon examination to show the fungus parasite in some stage of resting spore development. It seems reasonable to conclude, as the large numbers of dead and dying males were found at a time when the females were laying eggs, that fertilization of the females had taken place in most instances and that the dead and dying males were largely spent individuals. It is not possible, however, to state whether or not the dead male insects found in early, or mid-season, in which it will be recalled conidia only occurred, had mated, but in any event such individuals were relatively few in numbers.

An examination of the healthy as well as the infected male insects, particularly toward the end of the brood, showed that the anterior portion of the abdomen was invariably empty. The genitalia and nearly all of the other internal organs were concentrated in the last four or five segments of the abdomen. This condition was also observed by Mr. R. E. Snodgrass of the Bureau of Entomology, who found furthermore that a sac was

¹ It is perhaps appropriate at this time to point out that Dr. Roland Thaxter, of Harvard University, who possesses the type of *Entomophthora arrenoctona* Giard, believes this fungus to be identical with *Entomophthora caroliniana* (Thaxt.). Although both descriptions were published in 1888, that of Thaxter appeared in April, and that of Giard some time after July 11. Hence the name *Entomophthora caroliniana* (haxt.) is the correct one and should be used for the fungus in question.

formed in the anterior portion of the abdomen which upon enlargement and inflation pushed the genitalia to the position indicated, and also pushed the intestine which normally in most insects lies close to the ventral abdominal wall to a position upon the dorsal wall. This sac becomes so large that it occupies the greater part of the abdomen, and in the opinion of Mr. Snodgrass it may act as an air reservoir in both sexes, and in addition, in the male, have a resounding function for the stridulatory apparatus. In any event a portion of the wall of this sac forms a septum across the body cavity, effectually separating the genitalia and other organs from the empty anterior portion of the abdomen, and the fungus which lives entirely upon the softer tissues of the insect's body is therefore limited in its development to the last four or five segments of the body in which the genitalia and other similar organs are concentrated.

As the conidial and the resting spore conditions do not occur simultaneously in the same individual and as the insects in which conidia are formed present quite a different appearance from those in which resting spores occur, it seems advisable to consider each phase of development separately.

CONIDIAL DEVELOPMENT

Infected individuals showing the conidial stages of the fungus appear in a way such as is illustrated on Plate 5, Fig. 1.² Specimens such as those shown, were usually found lying dead upon the ground beneath trees, or in open roadways, although very often a similarly afflicted cicada was observed flying around in an unsteady manner, or crawling feebly about. Unfortunately no specimens showing an earlier phase of the disease were collected, and therefore while the method of formation of the conidia was followed in several instances, an earlier stage homologous to the "hyphal body" stage of other Entomophthorales was not observed.

The fungus thus confined in its vegetative growth to the softer

² In the specimens shown the wings and legs were removed artificially in certain instances, in order better to expose the fungus mass for photographic purposes, and in the individuals shown on Plate 5, Fig. 2, a portion of certain of the abdominal rings was removed for the same purpose.

tissues in the posterior segments of the body of the host, ultimately destroys all such tissues, including the flexible intersegmental membranes of the abdomen in this region. As a result of the complete destruction of these membranes the posterior abdominal segments slough off until a condition such as that illustrated on Plate 5, Figs. 1 *B* and *C* is reached. The sloughing off process takes place progressively, beginning with the last segment and continues until four or more have been dropped, the last remaining one marking the position of the septum referred to above. The insect does not die at the time the first segments are dropped. On the contrary it remains alive for a considerable period and continues to fly and crawl about from place to place.

As far as the writer is aware such a sloughing off process, taking place while the host is alive, is quite unknown in other insects attacked by other members of the Entomophthorales, and in fact the phenomenon is so unusual that it has been noted by practically every person who has observed the disease in the field. The appearance of insects crawling and flying about with but two or three abdominal segments attached to the thorax, is indeed sufficiently striking to attract the attention of any one.

The fungus mass, including the conidia, which morphologically is of endogenous origin, becomes exposed as fast as the body segments of the host rot away, and the movements of the insect from place to place serve to disseminate the conidia in a way that could scarcely be improved by any natural method. It will be recalled that in most of the entomogenous entomophthorales, the conidia are borne upon conidiophores which bore their way outward through the body wall of the host, and that they are violently ejected from the conidiophores only after the host is dead and therefore stationary. Although the conidia are thrown to some distance, such a method seems inefficient when it is compared with the process which takes place in the present instance, in which the live, actively moving infected host mingles promiscuously with its fellows.

The fungus when intact forms a clay colored pustule like, granular mass at the tip of the abdomen. In certain individuals such as is shown on Plate 5, Fig. 1 *C* the pustule is quite large,

assuming the size and conformation of that part of the abdomen which it formally occupied. In other specimens Plate 5, Fig. 1 *B* and *D*, the pustule is asymmetrical and ragged. Such specimens as the latter are evidently old ones, from which a large part of the conidia were detached when the hosts were alive and moving about. Upon microscopic examination the pustule is found to be composed almost wholly of conidia, although if search is made deep within the mass close to the septum, conidiophores and the characteristic entomophthoroid hyphal fragments may also be seen.

As noted above, in the species of *Entomophthora*, the conidia are violently discharged from the conidiophores. In *Massospora*, however, the conidia are formed within the body of the host, and although they are cut off in the usual manner their ejection is prevented by the body wall of the insect, which when they are cut off is intact, and holds them in the approximate position in which they are produced. The conidia therefore cohere with one another and a mass is formed which upon disintegration of the intersegmental abdominal membranes is exposed, and assumes the form of a pustule such as is described above. The movement of the host at this period is perhaps the most important factor in loosening the segments of the abdomen, the membranes connecting which have been destroyed by the vegetative development of the fungus so that the movements of the insects not only serve to scatter the conidia of the fungus, but first free them from captivity.

The conidia are, so far as the writer has been able to determine, all of one type, which conforms in most respects to that of the other *Entomophthorales*. They are quite regularly oval in form, measuring $10-14 \times 14-17$ microns. The papilla, an outgrowth characteristic of the conidia of all members of the family, is usually not prominent, though always noticeable. Occasionally it stands out conspicuously in a manner such as is shown on Plate 6, Fig. *A*. Unlike other members of the family, however, the conidial walls are regularly verrucose, which condition renders them unique in appearance. It should be noted, however, that there is a tendency for them to lose the warted appearance if they are permitted to remain in water for a short time.

The method of formation of the conidia and the manner in which they are cut off seems quite like the analogous processes in other species and need not be discussed here.

When viable conidia were placed upon a slide in a moist chamber, or when they were sewn upon a nutrient agar, germination usually took place in a manner such as is illustrated on Plate 6, Figs. 2-3, namely, by one or more rather stout, long, germ tubes. Occasionally, however, a single rather stout germ tube arose, the terminal portion of which became swollen, Plate 6, Fig *D*, as though to form a secondary conidium, but at this point development invariably ceased.

In connection with the germination tests, attempts were made to grow the fungus artificially. The media used were potato agar, Molische's agar, oat agar, and nutrient beef broth. In addition to these nutrients, the genitalia and other organs, upon which the fungus normally grows in nature, were removed aseptically from live, healthy cicadas and employed without sterilization, for the same purpose. No growth of the fungus was obtained, however, upon either the unsterilized tissues from freshly killed insects, or upon the other nutrients noted above.

The conidia when placed in a suitable situation germinate with great rapidity, a growth such as that illustrated on Plate 6, Fig. *B-C*, taking place within three hours, but after such a short, rapid, preliminary growth development ceased in every instance in the writer's tests.

RESTING SPORE DEVELOPMENT

Up to the present time resting spores have not been definitely associated with the organism in question, although Peck (1879) vaguely described bodies, which Thaxter (1888) subsequently tentatively regarded as resting spores. In the light of these investigations furthermore, it likewise appears that many of the early notes about the fungus contain references to the resting spore condition, although the descriptions were of such a nature that they might have applied equally well to the conidial growth.

As noted above the resting spore condition, which was never found associated with the conidial condition, was very prevalent

about Washington in 1919, from 50-90 per cent of the male insects showing this stage of the fungus during the latter part of the season.

In its vegetative growth prior to the production of resting spores, the fungus destroys the intersegmental abdominal membranes of the host, as it does in the conidial phase of the development just considered, and there is a similar sloughing off of the abdominal segments. The septum described above, across the body cavity of the insect, which normally persists in insects affected with the conidial growth is, however, destroyed in most instances during the formation of the resting spores, and although these bodies arise upon the soft tissues concentrated in the last four or five posterior segments of the body, they may be found, owing to the absence of the septum, in some numbers, within the otherwise empty anterior portion of the abdomen.

The resting spore-mass which is, nevertheless, largely confined to the posterior segments, presents a granular appearance and is of a sulphur yellow color, tinged with green when young, but it assumes a dark brown color when the resting spores are mature. These bodies are less coherent in the mass than are the conidia, and as a result they are scattered about by the movements of the host much more freely. It was in fact not uncommon to observe an infected individual in which the empty body cavity formed one continuous passage from the last abdominal segment to the head, with two or three of its abdominal segments missing, actively crawling or flying about. In this respect the appearance of cicadas showing the resting spores, differs from those showing the conidial growth, because it will be recalled there occurs in the latter a persistent fungus stroma closely associated with the above-mentioned septum, which after the abdominal segments have been dropped, remains as a continuous partition across the abdomen.

It can therefore be readily seen that, though both of the reproductive phases have many characteristics in common, there are nevertheless certain characters by which one phase may be readily distinguished from the other merely by a superficial examination.

Microscopically the 'mature resting spores, or as they perhaps should be called, azygospores, appear as spherical, slightly brownish bodies, the outer wall of which is beautifully reticulated in a manner such as is shown on Plate 6, Fig. T. They are remarkably uniform in size, measuring 38-48 microns in diameter, averaging 44 microns.

Unfortunately all stages in the development of these azygospores were not seen in fresh material and particularly those stages associated with the transfer of protoplasmic material from the hyphal body to the resting spore. Alcoholic material, which it may be stated was all collected in the daytime, indicates, however, that the process is a non-sexual one, and that the azygospores arise as buds or outgrowths upon the hyphal bodies into which, as they enlarge, flows the entire protoplasmic contents of the hyphal body, the empty and evanescent walls of which sometimes remain attached to the mature resting spores.

The writer showed (Speare, 1912) in connection with *Entomophthora pseudococci* that the presence or absence of daylight, at the time of maturity of the hyphal bodies, predetermined to a large extent the type of reproductive body that was formed, and that the azygospores of the fungus in question, could be produced at will, by placing artificial cultures of the fungus in a dark situation a few hours before the hyphal bodies were ready to "germinate." It would therefore seem reasonable, if one desired to collect the early resting spore stages in such a similar form as *Massospora cicadina*, to search for them during the night, yet, inadvertently no collections were made at this time in the present investigation. Nevertheless, the alcoholic material shows with reasonable certainty that no sexual process is present, and that the development of the resting spores, conforms quite well with the development of the azygospores in other members of the family such as *Entomophthora aulicae* Reich.

The resting spores of *Massospora cicadina* like the analogous bodies of many other of the entomogenous species of the family have never been seen to germinate. In the writer's tests a number of them were heated at varying degrees of temperature, and a number were permitted to remain out-of-doors all winter, yet no

germination was observed, when, after such treatment they were suspended in a drop of water in Van Tieghem cells. Similar negative results were obtained in attempts to germinate resting spores that had previously been treated with dilute hydrochloric acid for a short time.

The writer has obtained no information in these studies regarding the manner by which *Massospora cicadina* passes the 16 years and 9 months' subterranean existence of its host. That it lives during this period either on the larvae of *T. septendecim*, or on other similar biennial cicadas seems the reasonable supposition, yet there is no evidence at hand to support this theory. It is probable that when it has been determined how, for example, *Entomophthora muscae* and other species that are not known to form resting spores, live over winter (see Lakon, 1919 *b*), information will be at hand that will be of value in solving the peculiar conditions involved in the present instance.

From the economic viewpoint it must be stated that if the fungus is confined largely to spent males and does not attack and kill the larvae (the writer observed it only on adult individuals), its importance as a natural check to the spread of this insect is almost negligible. Investigation should be made, however, of larvae two or three years before their emergence in order to determine whether or not the fungus is present.

These studies show, it is hoped, that there can no longer be any question regarding the relationship of *Massospora cicadina* to other entomogenous Entomophthorales, and that while it is a very distinct form in many respects, it falls quite naturally into the above mentioned family.

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EXPLANATION OF PLATES

PLATE 5

Fig. 1. Specimens of *Tibicina septendecim* showing the conidia of *Massospora cicadina*. Although certain organs of these insects were removed artificially, the abdomen with the attached fungus mass is shown in each instance exactly as it was observed in the field. Fig. 1A is a female individual and shows an unusually large conidial mass. $\times 1$.

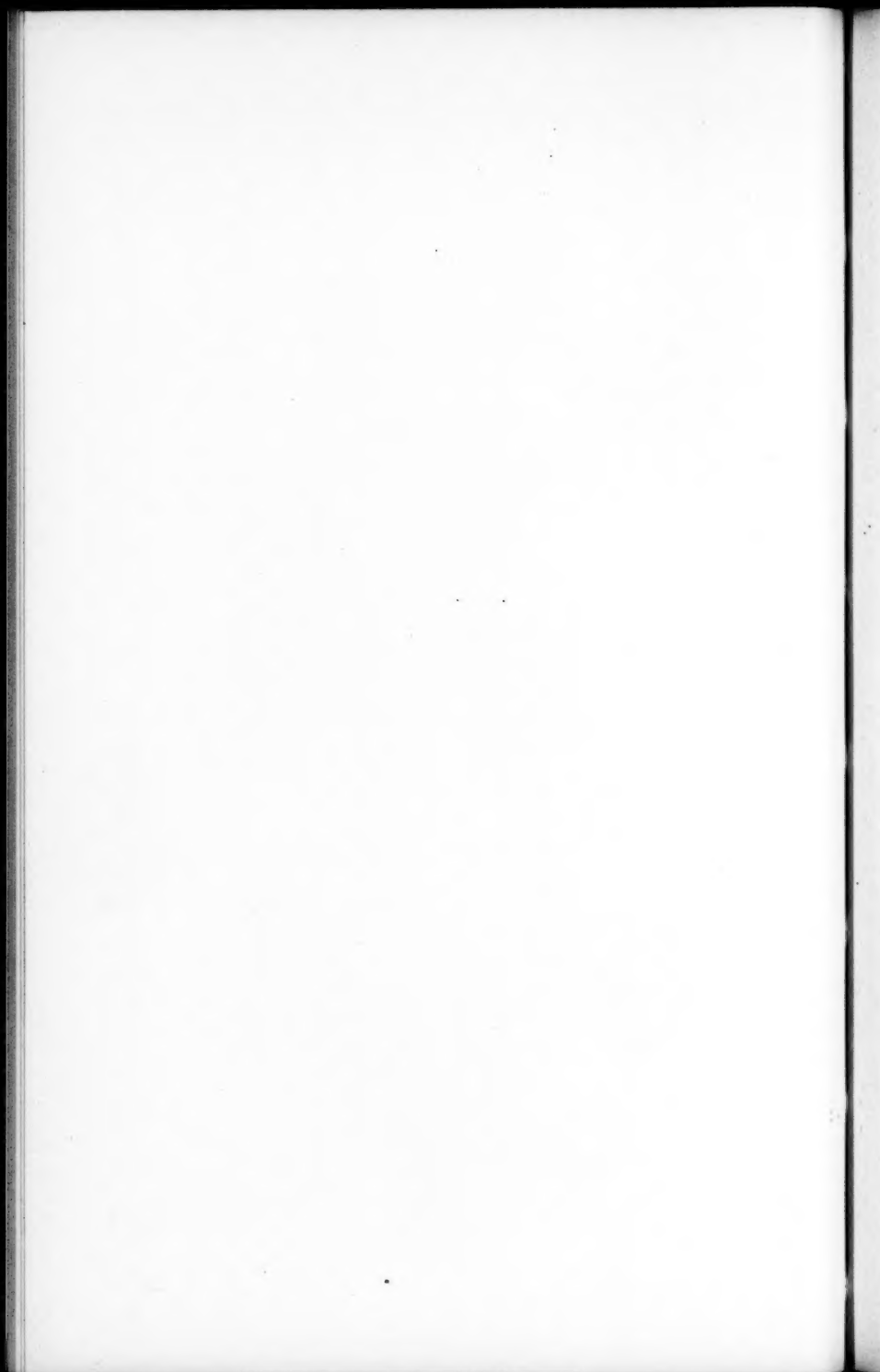
Fig. 2. Specimens of *Tibicina septendecim* showing the resting spores of *M. cicadina*. In Fig. 2A a portion of the anterior four abdominal segments were removed artificially. Fig. 2B shows the fungus mass within the abdomen, viewed from a posterior position. $\times 1$.

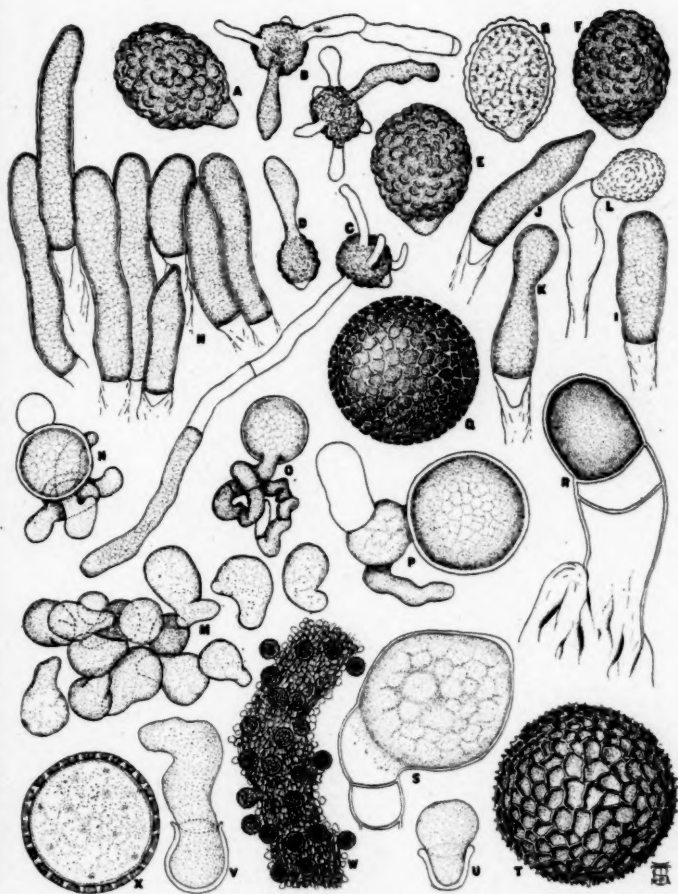
PLATE 6

- Figs. A, E, F. Conidia of *Massospora cicadina*. $\times 1048$.
- Figs. B, C, D. Conidia germinating. $\times 568$.
- Fig. G. Optical cross section of conidium showing its thick wall. $\times 1048$.
- Fig. H. A group of conidiophores. $\times 568$.
- Figs. I, J, K, L. Selected conidiophores showing the method of formation of the conidia. $\times 568$.
- Fig. M. Gourd shaped hyphal bodies associated with the resting spore condition. $\times 268$.
- Figs. N, O. Young resting spores with hyphal bodies attached. $\times 268$.
- Figs. P, S. Young resting spores with hyphal bodies attached. $\times 532$.
- Fig. Q. A stage in resting spore development intermediate between those shown in Figs. P and T. $\times 532$.
- Fig. R. Apparently an encysted hyphal body. $\times 532$.
- Fig. T. Mature resting spore. $\times 568$.
- Figs. U, V. Hyphal elements of unknown origin and function found associated with the resting spore condition. $\times 568$.
- Fig. W. A portion of one of the tube-like genital organs, showing resting spores and hyphal bodies adhering. $\times 62$.
- Fig. X. Optical cross section of a resting spore in about the stage of development shown in Fig. Q. $\times 532$.

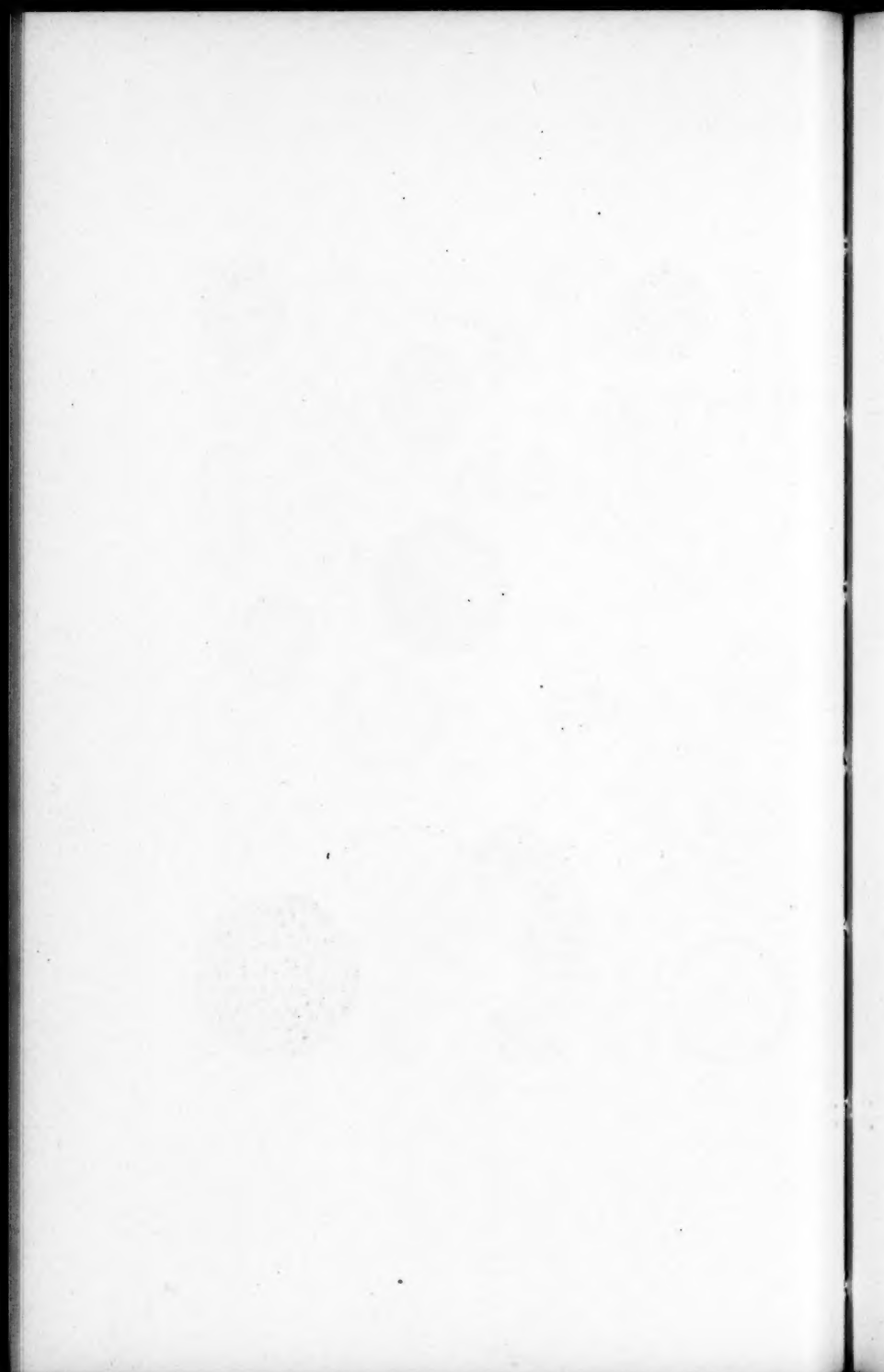


1. (Above.) CONIDIA ON TIBICINA
2. RESTING SPORES ON TIBICINA





MASSOSPORA CICADINA Peck



LIGHT-COLORED RESUPINATE POLYPORES—III

WILLIAM A. MURRILL

The last number of this series, which appeared in MYCOLOGIA for November, 1920, dealt chiefly with white species. In the present article, I shall mainly discuss species that are rose-colored, lilac, red, or purple; or that show tints of these colors.

48. *PORIA EUPORA* (P. Karst.) Cooke, Grevillea **14**: 110. 1886
Polyporus euporus P. Karst. Not. Sällsk. Faun. Fl. Fenn. **9**: 360. 1868.
Polyporus attenuatus Peck, Bull. Buffalo Soc. Nat. Sci. **1**: 61. 1873; Ann. Rep. N. Y. State Mus. **26**: 70. 1874.
Polyporus Blyttii Fries, Hymen. Eur. 571. 1874.
Poria Blyttii P. Karst. Bidr. Finl. Nat. Folk **37**: 83. 1882.
Poria attenuata Cooke, Grevillea **14**: 110. 1886.

Originally described as follows from specimens collected on dead willow wood in Finland by Karsten, who notes that it is not rare:

"Effusus, adhaerens vel adnatus, tenuis, submicans, ambitu byssaceo-contextu albo; pori minuti, subangulati, demum saepius laceri, curti, testaceo-lutei."

The type of *P. Blyttii* is at Christiania. At Upsala I found two specimens under this name, one white and the other rosy-isabel-line, the latter being the correct one. According to Bresadola, *Polyporus collabens* Fries and *P. emollitus* Fries are forms of *P. Blyttii* Fries, and his statement appears to be supported by original specimens in his herbarium. Specimens from Karsten show that *P. euporus* is not distinct. It may be that the name here used will have to give way to *P. nitida* Pers. See discussion under that species.

The most complete description of this fungus is that recently

published by Overholts, the various original descriptions being brief and inadequate. He finds the spores $3-4 \times 2-3 \mu$ and the cystidia $60-80 \times 7.5-10 \mu$. Bresadola measured the spores as $4-4.5 \times 2-2.5 \mu$.

This species occurs on linden, poplar, oak, birch, beech, willow, etc., in Europe; and in this country on maple, oak, witch hazel, alder, willow, linden, ironwood, and certain other deciduous trees. I have found it very common on red maple. A specimen from Bresadola collected by Eichler on *Pinus sylvestris* exactly agrees with ours on maple in gross characters, and Bresadola finds the spores to be the same, but the cystidia less abundant. Peck's variety *subincarnata* occurs on hemlock, but this is a distinct species.

Ellis, N. Am. Fungi 921; Canada, Faull 47, 49, Macoun 36 (177), 41, 121, 133, 141, 145, 223, 397, 458, 499; Newfoundland, Waghorne 691; Maine, Murrill 1747, 2010, 2167; Vermont, Burt; New Hampshire, Underwood; Connecticut, Underwood 550; New York, Cook, 93, Murrill 64, Underwood, Van Hook (Cornell University 7896), Van Hook & Smith (Cornell University 8067); Pennsylvania, Everhart & Haines, Herbst, Sumstine 63; Ohio, James 10, Lloyd 379, 2788, 2789, 3116, Morgan 77, 81; Indiana, Underwood; Iowa, Holway 208; Florida, Calkins.

49. *PORIA VINCTA* (Berk.) Cooke, Grevillea 14: 110. 1886

Polyporus vinctus Berk. Ann. Mag. Nat. Hist. II. 9: 196. 1852.

Polyporus carneopallens Berk. Hook. Jour. Bot. 8: 235. 1856.

?*Polyporus Fendleri* Berk. & Curt. Jour. Linn. Soc. 10: 317. 1868.

Polyporus epilinteus Berk. & Br. Jour. Linn. Soc. 14: 55. 1875.

Described as follows from specimens collected by Sallé in Santo Domingo and still preserved at Kew:

"Totus resupinatus, centro crassiusculus margine tenuis subliberatus supra sanguineo-tinctus; poris minimis pallidis contextu lignicolori. Sallé, no. 34. On dead wood.

"Spreading for many inches over the decayed wood, 2 lines or more thick in the centre, very thin at the extreme margin, where the upper surface is separable, smooth, and stained with blood-color. Pores scarcely visible to the naked eye, pallid, a line or more long; dissepiments thin; substance wood-color."

P. carneopallens was described from Spruce's collections in Brazil, *P. Fendleri* from Fendler's collections in Venezuela, and *P. epilinteus* from Ceylon. According to Cooke, one of the original type specimens of the last species has orange mycelium while the two others are without it. *Poria cassicola* Bres., recently described from Brazil, is nearly related. *Poria lilacina* Speg., collected by Balansa in Paraguay, is apparently not distinct.

This species is rosy-isabelline when fresh, like *P. eupora*, with which it is easily confused. It occurs throughout tropical regions on dead wood of orange, acacia, etc., as indicated in the following collections:

Mexico, Murrill 238, 622, 869, 976, 979, 1029, 1045, 1187, 1190; Mexico or Nicaragua, Smith 244; Nicaragua, Smith 65a; Cuba, Earle & Murrill 80, 210, 325, Horne 197, Underwood & Earle 1208; Porto Rico, Johnston 430, Johnston & Stevenson 1495, Stevenson 2888, 2910, 3362; Danish West Indies, Raunkiaer 138, 171, 188, 239, 249, 264; Jamaica, Underwood 3287, Murrill & Harris 942, Murrill 37, 184, 228, 247, 249, 373, Earle 100, 219; Venezuela, Fendler; South America, Gaillard 65; Ceylon; also from New Zealand and Perak.

50. *Poria albirosea* sp. nov.

Effused for several centimeters, continuous, inseparable; margin appressed, membranous, white to rosy-isabelline, becoming inconspicuous with age; context pallid, a mere membrane; hymenium slightly uneven, not glistening, pallid to rosy-isabelline, becoming pale-chestnut-colored in spots when bruised or handled; tubes rigid, rather regular, angular, 3-4 to a mm., reaching 2 mm. in length, edges rather thin, entire; spores ovoid, smooth, hyaline, $5 \times 3 \mu$.

Type collected on well-rotted deciduous wood at Fern Hollow, Pennsylvania, July 13, 1906, David R. Sumstine 70. Also collected at three different times on dead wood in Canada by Macoun (probably near Ottawa), and at Wilmington, Delaware, Commons 2672. Langlois' No. 2543, from St. Martinsville, Louisiana, may belong here, but the tubes seem rather small.

51. *Poria subundata* sp. nov.

Effused for several centimeters, becoming continuous, closely appressed, inseparable, thin; margin inconspicuous, thin, appressed, white, soon disappearing; context pallid, not apparent in age; hymenium very oblique, beautifully undulated, not glistering, cremeous to pale-rosy-isabelline; tubes small, rigid, regular in size and shape, angular, 5 to a mm., 1 mm. or less long, edges thin, entire; spore characters not satisfactorily determined.

Type collected on a decayed standing stub of a hardwood tree in wet woods on Cooper's Ranch at the base of El Yunque Mountain, Baracoa, Cuba, March, 1903, *L. M. Underwood & F. S. Earle 1168*. Also collected on decayed hardwood in Troy and Tyre, Jamaica, January, 1909, *W. A. Murrill & W. Harris 1012*.

52. *Poria subincarnata* (Peck) sp. nov.

Poria attenuata subincarnata Peck, Ann. Rep. N. Y. State Mus. 48: 118. 1897.

Briefly described by Peck as follows, from specimens collected on fallen branches of *Tsuga canadensis* at Alcove, New York, by C. L. Shear in November, 1893:

"This differs from the typical form in the paler color of the pores. It grows on hemlock bark and forms small patches rarely more than 1 inch in diameter."

Overholts has described it at length after studying type material and specimens recently collected by himself in New Hampshire. He finds the spores allantoid, hyaline, $4-5 \times 1 \mu$; cystidia none. I have a number of collections—on fir, hemlock, *Cupressus thyoides*, alder, maple, etc.—all of which appear to be identical with the type at Albany. Various specimens collected by me in Maine and New York appeared milk-white to buff with an incarnate tint when fresh and are now pale-rosy-isabelline in the herbarium. Thin forms of *Poria eupora* from Karsten collected on willow greatly resemble this species at first glance, but under a hand lens they show darker and more rosy tints, while the microscope reveals their strikingly different spore characters.

Ellis & Everhart, Fungi Columb. 1; Canada, *Macoun 289, 570*; Newfoundland, *Waghorne 29*; Maine, *Murrill 1925, 1985, 1988*,

1989; New Hampshire, *Underwood*; New York, *Murrill* 2708, *Shear*; New Jersey, *Ellis*.

53. *Poria Dodgei* sp. nov.

Widely effused, continuous, inseparable, thick; margin conspicuous, but narrow in age, appressed, membranous, pale-rosy-isabelline; context membranous, rosy-fulvous; hymenium even, somewhat glistening, rosy-isabelline to rosy-fulvous; tubes rigid, quite regular, angular, rosy-fulvous within at maturity, 2-4 to a mm., reaching 5 mm. in length, edges thin, subentire; spores elongate, smooth, hyaline, $5.5 \times 2.5 \mu$.

Type collected on a decayed coniferous log at Krohns Lake, near Algoma, Wisconsin, by *B. O. Dodge*.

54. *PORIA INCARNATA* (Alb. & Schw.) Cooke, *Grevillea* 14: 112. 1886

Boletus incarnatus Alb. & Schw. *Consp. Fung.* 250. 1805.

Polyporus incarnatus Fries, *Syst. Myc.* 1: 379. 1821.

I have good specimens from Sweden and Trent, the latter collected by Bresadola on dead trunks of larch. Specimens from Florida sent to Ellis by Calkins and determined by Cooke as this species were compared by me with material at Upsala and found to be distinct. *Underwood*, while at Kew, studied plants from South Carolina in this connection and said that they seemed the same as specimens from Sweden. *Poria Dodgei* is nearly related.

55. *PORIA UNDATA* (Pers.) Bres. *Ann. Myc.* 1: 78. 1903

Polyporus undatus Pers. *Myc. Eur.* 2: 90. pl. 16, f. 3. 1825.

Polyporus cinctus Berk. *Outl. Brit. Fungol.* 250. 1860.

Polyporus subliberatus Berk. & Curt. *Jour. Linn. Soc.* 10: 318. 1868.

Polyporus Broomei Rab. *Fungi Eur.* 2004. 1876.

Polyporus odor Peck, *Ann. Rep. N. Y. State Mus.* 38: 92.

1885. Not *P. odor* Sommerf. *Suppl. Fl. Lapp.* 275. 1826;

Fries, *Elench. Fung.* 1: 90. 1828.

Poria nigrescens Bres. *Atti Accad. Roverto* III. 3: 83. 1897.

This species, so common in America, is usually labeled "*Poria*

callosa" or "*Poria corticola*," from both of which it is very distinct. Peck described it from specimens collected on spruce logs at Osceola, New York, and referred to its strong, disagreeable odor; but his name does not appear to have been known or used outside of the state herbarium.

The earliest tenable name applied to it seems to be that of Persoon, who described it from a specimen collected by Chaillat on dead wood. His colored figure shows the "waves" in the hymenium which suggested the name. Bresadola seemed to think in 1903 that Fries misapplied the name *Polyporus vitreus* Pers. to this species, and his opinion is supported by a specimen from Karsten collected on *Pinus sylvestris*. Another note I have from him, however, is to the effect that *Poria vitrea* Pers. is not specifically distinct from *P. undata*, but that the former is smooth and the latter an undulate variety. I see no difference between types of *Poria nigrescens* Bres. and specimens collected by Overholts at Oxford, Ohio. This blackening is not common and seems to be associated with thick, old forms which have "revived" the second or third year.

Fresh specimens are described as "pure-white," "yellow," "reddish-flesh-colored," etc., and as separating readily from the matrix. With specimens collected by Overholts on beech logs in Ohio are the following notes:

"Effused, separable, orbicular at first, then irregular, perennial, 2-3 mm. thick; margin thin, free, sterile, narrow, cottony, white; context inconspicuous; hymenium plane, gray, yellowish in weathered specimens; tubes stratified, pallid within, 2 mm. long each season; mouths circular, small, 6-7 to a mm., edges thin, entire; spores globose, smooth, hyaline, 3 μ in diameter."

Few species have such a wide distribution and find themselves at home on so many widely different hosts. Elm, beech, alder, orange, white oak, shingle oak, hemlock, spruce, fir, pine, Douglas spruce, and other trees are found mentioned as furnishing substrata for it; while the following list of specimens will indicate its distribution:

Barth. Fungi Columb. 5042; Rab. Fungi Eur. 2004; Zopf & Syd. Myc. Mar. 5; England, *Plowright*; Finland, *Karsten*; Ber-

lin, *Braun*, *Hennings*, *Magnus*, *Sydow*; Hungary, *Kmet*; Canada, *Dearness* 699B, 1113, 2046, *Macoun* 107; New Hampshire, *Wilson*; New York, *Ames*, *Atkinson* 22767, *Ballou*, *Underwood*, *Van Hook* (*Cornell University* 8255); New Jersey, *Ellis*; Pennsylvania, *Banker*, *Sumstine* 1, 6, 16, 17, 19, 55, 56; Delaware, *Commons* 2673; Ohio, *Gentry*, *Hard* (*Cornell University* 19618), *Lloyd* 1728, *Overholts* 23, 70; Indiana, *Underwood*, *Van Hook* 2192; Missouri, *Demetrio* 629; Arkansas, *Long* 19834; California, *Harper*, *Johnston* 253, 255; North Carolina, *Townsend* (*Cornell University* 5734); Alabama, *Earle* and *Underwood*; Mississippi, *Bartholomew* 5782; Louisiana, *Langlois* 48, 183, 1735, 2431; Florida, *Calkins* 853; Cuba, *Earle* 751, *Horne* 197, *Underwood & Earle* 745A; Danish West Indies, *Raunkiaer* 172; Panama Canal Zone, *Bethel*.

56. *PORIA BORBONICA* Pat. Jour. de Bot. 4: 198. 1890

Originally described as follows from specimens collected on bark on Reunion Island:

"Résupiné, dur, compact, entièrement gris de souris, marge nulle. Tubes obliques, longs de 5 millimètres, implantés directement sur le support; pores petits, arrondis, ou ovales allongés, entiers, à cloisons minces. Mycélium blanc, floconneux, abondant, entourant la plante d'une large bordure soyeuse.

"Plante formant des plaques denses, larges de 10-20 centimètres. Le mycélium pénètre profondément dans l'écorce et donne naissance à des couches blanches à la manière du *Poria corticola*."

This species is widely distributed and quite common in tropical regions on dead trunks of mango, cocoanut, etc. When young and fresh, the hymenium is very light russet with a glaucous bloom. The following specimens have been examined:

Cuba, *Baker* 3885, *Earle* 265, 653, *Earle & Murrill* 338, 484, 492; Porto Rico, *Britton*, *Brown & Cowell* 5360, *Johnston* 678, *Johnston & Stevenson* 1502, 1606, *Santiago* 33; Jamaica, *Earle* 226, 547, 556, *Murrill* 14, 61, 139, 1124, 1144, *Underwood* 3470; Danish West Indies, *Raunkiaer* 128, 133, 135, 176, 195; Montserrat, West Indies, *Shafer* 902; Guadeloupe, *Duss* 7; Africa, *Dusen*.

Owing to the difficulty in finding spores, I can not say positively that the specimens listed below from Florida and adjacent states are the same as those given above. They are very similar, but without the glaucous bloom, which may have been removed by some treatment to destroy insects.

Ellis & Everhart, N. Am. Fungi 2304; Louisiana, *Langlois* 1274, 1736, 1879, 2544, 2545, 2552; Florida, *Calkins* 20, 635, 644, 704.

57. *PORIA LATERITIA* Pat. Bull. Soc. Myc. Fr. 15: 200. 1899

Described as follows from specimens collected by Duss on a dead trunk of *Symplocos martinicensis* in Guadeloupe:

"Larges plaques dures, ligneuses, planes ou à peine bosselées, grises à la surface, rouge brique à l'intérieur; pores superficiels (100 μ de profondeur), très petits (50-65 μ de diamètre), anguleux-sinueux, irréguliers, à cloisons minces, rigides, de 20-30 μ d'épaisseur, grises dans leur portion libre avec la tranche blanchâtre, souvent incomplètes et prenant alors l'aspect irpicoïde. Trame épaisse de 1 à 3 millim., brique, dure, traversée par les cloisons.

"Espèce distincte de *P. aurantiotingens* par sa trame rouge brique et non brune ou noirâtre."

I have specimens from Duss (No 592) collected on *Symplocos* and also a fine collection made on Fergus Mountain, Montserrat, January 30, 1907, *J. A. Shafer* 886. The latter specimens show the cinereous hymenial surface and the brick-red, stratose interior so characteristic of the species, as well as a handsome, smooth, dark-brown border encircling the fungus.

58. *PORIA SANGUINOLENTA* (Alb. & Schw.) Cooke, *Grevillea* 14: 112. 1886

Boletus sanguinolentus Alb. & Schw. *Consp. Fung.* 257. 1805.
Polyporus sanguinolentus Fries, *Syst. Myc.* 1: 383. 1821.

The only American specimen that appears to belong here is one collected on rotten wood at Ottawa, Canada, by Macoun, February 10, 1883. Ellis collected specimens on oak at Newfield, New Jersey, which resemble authentic material, but their identity

is in doubt. His N. A. F. 1306, on cedar, seems to me distinct, although it was milk-white when young and fresh. Specimens collected by me on spruce near Stockholm, Sweden, in 1910, and determined by Romell, as well as by comparison with specimens from Karsten, were described by me in the field as follows: "Margin milk-white, slightly ragged and cobwebby; hymenium discolored at the center with brownish-chestnut tints as though bruised or stained with blood. The discolorations are not brilliant, however, but look more like old blood stains."

Bresadola reports the species from Hungary on poplar, beech, and walnut. Specimens from Poland on pine are said by him to be much thinner and quite distinct in appearance, being very similar to *P. violacea*, with which he says this form is often confused. According to him, the spores are $6-8 \times 2-2.5 \mu$, and the hymenophore is at first white, then stained with red, drying incarnate, and becoming purple or violet-fuscos in the herbarium. His idea of the species is quite different from Romell's and Karsten's, and specimens so named from him appear very similar to *P. purpurea*.

Krieger, Fungi Sax. 421; Roum. Fungi Gall. 3113; Sweden, Murrill; Finland, Karsten; Belgium, Bommer & Rousseau; Saxony, Krieger; Canada, Macoun 130.

59. *Poria Bracei* sp. nov.

Widely effused over the soil or decayed organic matter, following the irregularities of the surface and reviving from year to year until it forms extensive mats a centimeter or more thick; margin very broad and conspicuous, membranous, persistent, pale-wine-colored to lilac or rose-colored; context conspicuous, becoming rose-bay with age; hymenium appearing in patches, but soon continuous and fairly even, roseous to darker, not glistening; tubes regular in size and shape, roseous to darker within, 1-2 mm. long each season, mouths circular, 4 to a mm., edges rather thick, entire; spores globose, hyaline, 4μ .

Type collected on the bottom of a barrel at Nassau, New Providence, Bahamas, in 1918, *L. J. K. Brace* 9594. Also collected on dead wood at Nassau, December 15, 1918, *Brace* 9764; on the ground at Nassau, in 1904, *Brace* 836½; and on the

ground at Rio Piedras, Porto Rico, February 22, 1914, *J. R. Johnston & J. A. Stevenson* 1427.

60. *PORIA VIOLACEA* (Fries) Cooke, *Grevillea* 14: 112. 1886
Polyporus violaceus Fries, *Obs. Myc.* 2: 263. 1818.

According to Bresadola, this very rare species is scarcely known by mycologists, even Fries himself confusing it with other species. The color, he says, is constant, dilute-violet; subiculum exceedingly thin; tubes 2 to a mm., very short, resembling those of *Merulius*; spores hyaline, $5 \times 2.5-3 \mu$. Specimens collected by him at Trent on *Abies* resemble very closely what I am calling *Poria purpurea*, but Bresadola says that the spores of the latter species measure $7-8 \times 2-2.5 \mu$ and are cylindric-curved. Specimens labeled *Poria violacea* by Ellis and others have a distinct subiculum and differ in other ways. See *Poria taxicola*.

61. *PORIA PURPUREA* (Hall.) Cooke, *Grevillea* 14: 112. 1886
Polyporus purpureus Fries, *Syst. Myc.* 1: 379. 1821.
Boletus lilacinus Schw. *Schr. Nat. Ges. Leipzig* 1: 74. 1822.
?Polyporus oxydatus Berk. & Curt. *Jour. Linn. Soc.* 10: 317. 1868.

This is No. 2274 in Haller's list of Switzerland plants, collected on beech logs. Specimens described by Schweinitz were collected in North Carolina. The distribution in America is indicated by the list of specimens below, many of which have been called *Poria micans* Ehrenb., a species not found in America, but, according to Bresadola, well represented by *P. albocarneo-gilvidus* Romell, collected on oak in Sweden and distributed by Romell. The American hosts of *P. purpurea* are red maple, magnolia, sycamore, live oak, and pine.

Canada, *Dearness* 1075, *Macoun* 141; New York, *Cook*; Pennsylvania, *Witte* 38; West Virginia, *Nuttall* 223; Ohio, *Lloyd* 2811, *Morgan* 90; Indiana, *Underwood*; Colorado, *Cockerell* 76; Kansas, *Bartholomew* 2060, *Kellerman & Swingle* 1381; Oregon, *Murill* 926; California, *McClatchie* 1071, *Parish* 2975, *Parks* 1022.

In addition to the above, there are a few specimens which I can not definitely connect up with this species without having more stages. They appear to be young and are distinctly lilac in the dried state, with smaller tubes than those of typical *P. purpurea*, reminding one strongly of *Poria aurantio-canescens* P. Henn., found on poplar in Berlin.

Pennsylvania, *Murrill 1190*; Delaware, *Commons 2163*; Ohio, *Lloyd 3560*, *Morgan 325*.

62. *Poria subbadia* sp. nov.

Irregularly effused for several centimeters, becoming continuous, closely adhering, rather thin; margin thin, appressed, arachnoid, white to rosy-isabelline, inconspicuous with age; context white to rose-colored, at first a mere membrane on which the tubes appear in patches, scarcely apparent in mature specimens; hymenium very uneven, not glistening, testaceous to pale-bay in dried specimens; tubes irregular, angular, collapsing to some extent, 2-3 to a mm., 1 mm. long, edges thin, becoming lacerate-dentate; spores smooth, ellipsoid, distinctly roseous under the microscope, $5 \times 3 \mu$.

Type collected by *L. M. Underwood* on a dead trunk at Auburn, Alabama, in February, 1896. Also collected in Bermuda on dead fiddlewood, December, 1912, *Brown, Britton, & Seaver 1418*.

63. *Poria mutans tenuis* Peck, Ann. Rep. N. Y. State Mus.

43: 39. 1890

Collected by Peck on spruce at Sevey, New York, in July. Little can be added to what Peck and Overholts have published about this plant until more mature specimens have been found and studied. After a careful examination of type material, I must conclude with Overholts that the variety seems quite distinct from *P. mutans*, being much thinner, softer, and differently colored. It differs from *P. purpurea* in color and in having a distinct subiculum; and from *P. taxicola* in color and in the shape of its tubes, although having a similar, well-developed subiculum. Compare *Poria nitida* Pers.

64. *PORIA NITIDA* (Pers.) Cooke, Grevillea 14: 110. 1886
Boletus nitidus Pers. Obs. Myc. 2: 15. pl. 4, f. 1. 1799.

According to Bresadola, Persoon's original plant is quite distinct from Fries' interpretation of it. An excellent specimen collected on pine in Poland was recently sent me by Bresadola and I find it strikingly similar to *Poria mutans tenuis* Peck. The specimens so labeled in American herbaria are mostly confused with *P. eupora* and *P. vincta*. *Poria nitida crocea* Schw. at Paris from French Guiana is near *P. spissa*. In his paper on Poland fungi, Bresadola gives the following description of *P. nitida*:

"Subiculum ut plurimum manifestissimum, usque ad 6 mm crassum, aurantiacum, in magis evolutis basi album, in exsiccatis saepe roseum, ex hyphis crasse tunicatis, 3-6 μ crassis, conflatum; tubuli et pori carnosius, molles, colore primitus carneolo dein vitellino vel aurantio-incarnato, compressione vel tactu fusciscentes, mox collapsi; sporae hyalinae, oblongae, 5-6 x 2½-3 μ ."

In opposition to Bresadola's opinion, I have a note made in Persoon's herbarium at Leiden in 1906 to the effect that *Poria nitida* Pers. is near, if not the same as, *P. attenuata* Peck, and that Bresadola did not see Persoon's specimens. This would make the Friesian interpretation of the species more correct and our American specimens so labeled would not be far wrong. If I could see Pers. Obs. Myc. 2: pl. 4, f. 1 (which is not in our library) and compare it with my plants, I believe I could settle this question. Persoon's description is of little use.

65. *PORIA PAVONINA* Bres. Hedwigia 35: 282. 1896

Described as below from specimens collected at Blumenau, Brazil, by Dr. Möller. I have examined the types of this species in Bresadola's herbarium and there are good specimens in the Ellis Collection here. The color is very beautiful, varying from dark-lilac to pale-purple. The species is known only from Blumenau, Brazil, where it was collected three times by Möller. His no. 364, which is older than the other two collections, was incorrectly determined by Bresadola as *Poria favillacea*, a species described from New England.

"Late effusa, coriacea, adglutinata, vivide pavonina, expallens, margine obsoleto, subiculo, nullo; tubulis brevibus, 1 mm. longis; poris parvis, subangulatis; hyphis subhymenialibus, 2 μ .—Sporae non visae."

66. *PORIA TAXICOLA* (Pers.) Bres. Atti Accad. Rovereto III.
3: 80. 1897

Xylomyzon taxicola Pers. Myc. Eur. 2: 32. pl. 14, f. 4, 5. 1825.

Polyporus haematodes Rostk. in Sturm, Deuts. Fl. Pilze 4: 127.
pl. 62. 1838.

Merulius Ravenelii Berk. Grevillea 1: 69. 1872.

Polyporus sorbicola Fries, Hymen. Eur. 570. 1874.

Serpula rufa pinicola P. Karst. Hedwigia 35: 45. 1896.

This beautiful purple, white-bordered species was originally described and poorly figured by Persoon from specimens collected by Chaillat on the trunks of a conifer. Standing as it does on the border line between *Merulius* and *Poria*, it has received a number of names, both in this country and in Europe. Most of the herbarium specimens in the *Poria* sheets are called either *P. violacea* or *P. incarnata* by Fries, Karsten, Plowright, Ellis, and others. Burt includes it in *Merulius*,—as did Persoon,—and I have no desire to alter this arrangement. The hymenium is often strikingly merulioid when young. The spores are allantoid, hyaline, 3.5–4.5 \times 0.5–1.5 μ . It occurs on dead wood and bark of pine, spruce, fir, *Cupressus thyoides*, *Thuja occidentalis*, and other conifers. One specimen from Karsten is said to have been collected on a deciduous trunk.

Cooke, Fungi Brit. 409; Ellis & Everhart, Fungi Columb. 1; Ellis, N. Am. Fungi 1305; Rav. Fungi Car. 4: 9; de Thümen, Myc. Univ. 406; England, Eyre, Masee, Plowright; Finland, Karsten; Sweden, Murrill 611; New York, Earle 1653, Murrill 822; New Jersey, Ellis; Pennsylvania, Stevenson 463; Minnesota, Holway 234; South Carolina, Ravenel; Louisiana, Bethel.

67. *PORIA SUBRUF*A Ellis & Dearness, Proc. Can. Inst. 1: 89. 1897

The type collection was made by Dearness at Granton, Ontario, in November, 1896, on a rotten beech log. Unfortunately, none

of the material is in very good shape to compare with *Poria mutans* or other near relatives. The description is as follows:

"Resupinate, effused, mostly in small patches 2-4 cm. across, inseparable, soft, juicy, creamy-white when fresh, becoming reddish when dry; margin thin, membranaceous, narrow, almost wanting. Pores round to sub-angular, $\frac{1}{4}$ - $\frac{1}{2}$ cm. long, $\frac{1}{4}$ - $\frac{1}{2}$ mm. wide, dissepiments thin, margin acute but not lacerate. Spores elliptic-oblong, $4 \times 3 \mu$."

68. *PORIA SPISSA* (Schw.) Cooke, Grevillea 14: 110. 1886

Polyporus spissus Schw. in Fries, Elench. Fung. 1: 111. 1828.

Polyporus salmonicolor Berk. & Curt. Hook. Jour. Bot. 1: 104.

1849. Grevillea 1: 53. 1872.

Polyporus cruentatus Mont. Ann. Sci. Nat. 1: 129. 1854.

?*Polyporus lactificus* Peck, Ann. Rep. N. Y. State Mus. 38: 91. 1885.

Poria crocipora Cooke, Grevillea 14: 110. 1886.

Poria phlebiaeformis Berk.; Cooke, Grevillea 15: 24. 1886.

Originally described from Schweinitz' collections in North Carolina on hard trunks. Redescribed from Ravenel's collections in South Carolina on burnt wood, the authors supposing that Schweinitz sent a different plant to Fries under the name *P. spissus*. The original Schweinitzian description, however, calls for a plant with spadiceous tubes and Fries refers in his notes to distinct black lines and to its resemblance to the true *P. obliquus*, whose tubes are similarly oblique and somewhat spadiceous. Moreover, specimens in Hooker's herbarium were marked *P. spissus* by Schweinitz and excellent types of the same kind still exist in the Schweinitz herbarium.

P. phlebiaeformis is hardly mature enough to show its true characters. *P. lactificus* is also probably a young stage, the type material being sterile and too poor for comparison. When young, *P. spissa* is white, then pale-salmon-tinted with a whitish border. Ellis describes it as continuous for 2-3 feet, with a thin, narrow, subtomentose margin, showing at first only a faint tinge of salmon color, which becomes deeper and changes more or less to a dull-red in drying, turning reddish when bruised, and having a

very strong odor in drying; pores nearly round or subangular, 2-3 mm. long, resting on a separable substratum or membrane, which is of a soft, carnose nature, not very tough and about 1 mm. thick. The hymenium is stratose.

The range of this species is remarkable, as will be seen by examining the list of collections below. Among its hosts are apple, linden, red maple, ash, *Alnus rhombifolia*, old hymenophores of *Hapalopilus gilvus*, pine, and *Pinus radiata*.

Ellis & Everhart, Fungi Columb. 208; Ellis & Everhart, N. Am. Fungi 1594; Rav. Fungi Car. 1: 18; Canada, *Dearness* 1114; New York, *Ballou*, *Burnham*, *Cook*, *Underwood*; New Jersey, *Ballou*, *Ellis*, *Martin* 102, *Southwick*; Pennsylvania, *Anderson*, *Miss Clarke* 1595, *Everhart & others* 279, *Haines* 58, *Sumstine* 33, 39; Delaware, *Commons* 2783; Ohio, *Fink* 17, *Lloyd* 1106, *Morgan* 327; Indiana, *Underwood*; Michigan, *Johnson* 631; Missouri, *Demetrio*; Oregon, *Carpenter* 43; California, *Gardner* 1095, *Johnston* 254; North Carolina, *Schweinitz*; South Carolina, *Ravenel*; Cuba, *Wright* 939; Guiana; Ecuador, *Lagerheim* 98.

69. *PORIA MUTANS* Peck, Ann. Rep. N. Y. State Mus. 43: 39.
1890

Polyporus mutans Peck, Ann. Rep. N. Y. State Mus. 41: 77.
1888.

Described as follows from specimens collected by Peck on chestnut wood at Selkirk; New York, in August:

"Resupinate, rather thick, tough, following the inequalities of the wood; pores minute, rotund, short, buff-yellow or cream color, becoming dingy red or dull incarnate where wounded, the subiculum fibrous, changing color like the pores, the whole plant assuming an incarnate hue when dried."

There are also specimens at Albany collected at Croghan, Bolton, and Savannah, New York; and I have six specimens collected on chestnut elsewhere, three from Connecticut, one from New Jersey, one from Pennsylvania, and one from Canada. The other specimens listed below may also be from chestnut, but the host is not mentioned in any case.

This species is closely related to *Poria spissa* and may be easily confused with it in herbarium specimens. Mr. Overholts found the spores to be hyaline, $3.5-5 \times 2.5-3.5 \mu$; cystidia none. In recently collected young specimens, I found copious spores measuring $3-4 \times 3 \mu$. In a collection made a few years ago, the spores were ovoid, smooth, hyaline, $3.5 \times 2.5 \mu$, and one flask-shaped, pointed, yellowish cystidium was found measuring $25 \times 8 \mu$. *Poria saloisensis* P. Karst. seems closely related, but is probably nearer *P. spissa*.

Canada, *Dearness*; Connecticut, *Clinton*, *Earle* 484, *Graves*; New York, *Ballou*; New Jersey, *P. Wilson*; Pennsylvania, *Sumstine* 5, 6, 10, 12, 14, 34, 66; Virginia, *Murrill* 389.

70. *PORIA INCRASSATA* (Berk. & Curt.) Burt, Ann. Mo. Bot. Gard. 4: 360. 1917

Merulius incrassatus Berk. & Curt. Hook. Lond. Jour. Bot. 1: 234. 1849; *Grevillea* 1: 70. 1872.

Merulius spissus Berk. *Grevillea* 1: 70. 1872.

Polyporus pineus Peck, Ann. Rep. N. Y. State Mus. 41: 78. 1888.

Poria pinea Sacc. Syll. Fung. 9: 194. 1891.

This very interesting species, which has been carefully studied both by Burt and Overholts, may be readily recognized by its large, dark spores. It somewhat resembles *P. taxicola* in gross characters, but belongs decidedly to *Poria* rather than to *Merulius*. Curtis collected his original specimens on a pine stump in South Carolina, and Peck obtained his on pine at Selkirk, New York. The margin is whitish or yellowish and the hymenium dingy-white, becoming purple to black with age. The spores are fuscous, $7.5-11 \times 4-7 \mu$, and there are no cystidia.

In addition to the original specimens already mentioned, which I have seen at Albany, Kew, and elsewhere, I find several specimens in the Ellis Collection that represent stages not shown in the types. One of these collections is assigned a manuscript name by Ellis and the following notes accompany it: "Margin narrow, erect, tomentose, white, the edges fringed with short, spine-like hairs or bristles; mouths of tubes white, dull-reddish within;

spores allantoid, hyaline, $10-12 \times 3.5 \mu$." This collection was made on dead limbs of *Pinus austriaca* at Newfield on Christmas day. Four other packets collected by Ellis on pine at Newfield bear as many different dates, and three are referred by him to *Poria violacea*.

The following specimens resemble those of the above species, but prove to be undeveloped resupinate forms of *Tyromyces Smallii* Murrill:

Auburn, Alabama, Earle, on pine bark; Newfield, New Jersey, Ellis, on old pine stump.

71. *PORIA SUBVIOLACEA* Ellis & Ev. Am. Nat. 31: 339. 1897

Described from specimens collected by Ellis on decaying white oak limbs buried beneath decaying leaves at Newfield, New Jersey, in September and October, 1896. I find only one packet so labeled in the Ellis Collection and it is practically destroyed by insects. Its date is October 1, while the description was drawn from specimens (which I do not find) collected on the same host, October 17. Ellis says that the hymenium is more or less tinged with violet or lilac at first, changing mostly to dirty-white or yellowish-white on drying. I imagine that the affinities of the species are rather with some of the thin, white forms previously studied than with the present group.

72. *PORIA CARYAE* (Schw.) Cooke, Grevillea 14: III. 1886

This species was treated in Mycologia for March, 1920. The specimens mentioned there as Ellis & Ev. N. Am. Fungi 2306, collected by Calkins in Florida, seem to be incorrectly determined and belong nearer to the *Poria vincta* group. Other good specimens found in the Ellis Herbarium are as follows:

Ohio, Morgan 229. This is probably a part of the same collection sent to Underwood in 1894, which has already been cited.

London, Canada, on beech, by Dearness 1343, December 6, 1889.

I have already referred to specimens collected by me on beech in northern Maine.

Kansas, Cragin 193.

73. *PORIA CAVERNULOSA* (Berk.) Cooke, Grevillea 14: 113. 1886

Polyporus cavernulosus Berk. Jour. Bot. & Kew. Misc. 8: 235. 1856.

Collected on dead branches at Panuré, Brazil, by Spruce and described as follows:

"Resupinate, orbicular, at length confluent, of a dirty fawn colour, darker in the centre, rigid; margin narrow, formed of matted down, but not byssoid; pores $\frac{1}{45}$ of an inch across, sub-hexagonal; edge rigid, sometimes elongated at the commissures, sometimes slightly waved."

Original specimens seen at Kew are not distinct from resupinate forms of *Trametes versatilis* Berk., although a totally different plant was found under this name at Paris and in the Fungi Cubenses Wrightiani. *P. byssoides* Jungh. in the Persoon herbarium at Leiden also seemed to me the same as *T. versatilis*, while Romell says that *Poria Düsenii* P. Henn. belongs in the same category.

NEW YORK BOTANICAL GARDEN.

SMUTS AND RUSTS OF UTAH—IV¹

A. O. GARRETT

USTILAGINALES

6. USTILAGO BROMIVORA (Tul.) Fisch. de Waldh.

In ovaries of *Bromus tectorum* L.: 2503, June 2, 1919, Salt Lake City. Another collection on the same host was made in October, 1919. 2755, August 20, 1920, Providence, Cache Co.

This smut was very abundant in the early summer of 1919 on this host on the "benches" around Salt Lake City. In 1920, it has been observed in equal abundance extending northward to the Idaho line. Previous to these collections, but one other collection was known for this host, Dr. Clinton informs me; and that was made by Dr. Hitchcock in Oregon.

9. USTILAGO HYPODYTES (Schlecht.) Fries

On *Oryzopsis hymenoides* (Roem. & Schult.), Ricker (*Eriocoma cuspidata* Nutt.): 2514, July 18, 1919, Price, Carbon Co.

On *Hilaria Jamesii* (Torr.) Benth.: 2508, July 18, 1919, Price, Carbon Co. Host determined by Mrs. Agnes Chase; smut by Dr. Clinton, to whose herbarium a specimen has been contributed. This is the first collection of the smut on this host.

12. USTILAGO LORENTZIANA Thüm.

In inflorescence of *Hordeum caespitosum* Scrib.: 2015c, June 15, 1909, Salt Lake City.

In inflorescence of *Sitanion Hystrix* (Nutt.) J. G. Smith; 2592, June 12, 1920, near East High School, Salt Lake City. Host determined by Dr. Hitchcock.

27. USTILAGO HIERONYMI Schröt.

In inflorescence of *Bouteloua curtipendula* (Michx.) Torr. (*B. racemosa* Lag.): A collection from Utah on this grass is listed in N. A. Flora 7¹: 13. 1906.

29. USTILAGO TRITICI (Pers.) Rostr. Overs. K. Danske Vid. Selsk. Forh. 1890: 15. 1890

In spikelets of *Triticum vulgare* L.: 2583, July 19, 1919, Castle Dale, Emery Co. 2692a, July 18, 1920, Cedar City, Iron Co. 2510, July 18, 1919, Price, Carbon Co.

¹ The previous papers of "Smut and Rusts of Utah" were published in MYCOLOGIA as follows: I, 2: 265-304, Nov., 1910; II, 6: 240-258, Sept., 1914; III, 11, 202-215, July, 1919.

UREDINALES

6. PUCCINIA INTERVENIENS (Pk.) Bethel in Univ. Cal. Pub. 7: 119. 1919

Aecidium roestelioides Ellis & Ever.

Puccinia Burnettii Griff.

The rust recorded under No. 101 of this list as *Puccinia Stipae* Arth. on *Stipa minor* (Vasey) Scrib. should be placed here. This collection was made Aug. 26, 1909, near Gogorza, Summit Co. Nearly defunct aecia on *Sidalcea nervata* (listed as No. 6 of the "Smuts and Rusts of Utah") were collected the same day in the immediate vicinity. Mrs. Clemens had made a collection of fine aecia in the same locality in May of the same year.

8. MELAMPSORA CONFLUENS (Pers.) Jackson, Brooklyn Bot. Gar. Mem. 1: 210. 1918

Caeoma confluens (Pers.) Schöt.

On *Grossularia inermis* (Ryd.) Cov. & Britt.: 2594, June 21, 1920, Gogorza, Summit Co. The gooseberry bushes were growing under the willow trees, and were very heavily infected. A single sorus was taken from the willows. 2621, July 1, 1920, Henry Ranch, above Panguitch Lake, Garfield Co.

On *Grossularia leptantha* (A. Gray) Cov. & Britt.: 2622, July 1, 1920, Henry Ranch, above Panguitch Lake, Garfield Co. Another collection on this host was made between Panguitch and Panguitch Lake.

On *Ribes petiolare* Dougl.: 2741, O, I, August 16, 1920, above Silver Lake, Big Cottonwood Canyon. The material was too old when collected, but Dr. Arthur considers it to belong to this species of rust. The writer has previously collected the rust on *G. inermis* within a quarter of a mile from where this collection was made. Willows were within a few feet of the bushes of *R. petiolare* from which the collection was made.

On *Salix Watsonii* (Bebb) Rydb.: 2593, II, June 21, 1920, Gogorza, Summit Co. A leaf with a few sori was taken from one willow. The gooseberries growing below were heavily infected with the *Caeoma* stage. 2637, II, July 15, 1920, same locality as No. 2593. The *Caeoma* on the gooseberries growing below the willows had all gone, leaving only scars on the leaves to show where it had been. 2772, III, Sept. 12, 1920, East Canyon, Summit Co.

9. GYMNOSPORANGIUM NELSONI Arth.

On *Juniperus utahensis* (Engelm.) Lemmon: 2511, July 18, 1919, Price, Carbon Co. 2607, June 25, 1920, Manti, San Pete Co. 2627, July 1, 1920, head Mammoth Creek above Panguitch Lake, Garfield Co. 2639, July 17, 1920, Maple Canyon branch of Cedar Canyon, near Cedar City, Iron Co.

On *Juniperus scopulorum* Sarg.: 2298, July 22, 1915, Logan Canyon, Cache Co. 2600, June 23, 1920, McGee Canyon, near Santaquin, Utah Co. 2645a, July 17, 1920, Maple Canyon branch Cedar Canyon, Iron Co. Some old cedar trees at the head of Coal Creek branch of Cedar Canyon had nearly every branch affected. 2698, July 29, 1920, Parowan Main Canyon, near Parowan, Iron Co.

On *Amelanchier mormonica* C. K. Schneider: 2718, Aug. 3, 1920, Beaver Canyon, near Beaver, Beaver Co. Host determined by Dr. Rydberg.

On *Amelanchier polycarpa* Greene: 2645, I, July 17, 1920, Maple Canyon branch of Cedar Canyon, about five miles from Cedar City, Iron Co. The host was determined by Dr. Rydberg.

On *Amelanchier Jonesiana* C. K. Schneider?: 2661a, I, July 19, 1920, Coal Creek branch, Cedar Canyon, about fifteen miles from Cedar City, Iron Co. The host is determined tentatively by Dr. Rydberg.

15. MELAMPSORELLA ELATINA (Albert & Schw.) Arth. I

Dr. Hedgcock, in his paper "Some Western Uredineae," states that the aecial stage of this rust (*Peridermium elatinum*) is conspicuous on *Abies lasiocarpa* (Hook.) Nutt, in the Manti National Forest.

17. PHRAGMIDIUM IVESIAE Sydow, II, III

Ph. affine Sydow.

On *Potentilla pulcherrima* Lehm.: 2759, Aug. 20, 1920, Richmond, Cache Co. Host determined by Dr. Rydberg.

19. PHRAGMIDIUM HORKELIAE Garrett

On *Ivesia Gordonii* (Hook.) T. & G.: 2744, Aug. 16, 1920, east slope from Twin Lakes, Big Cottonwood Canyon, Salt Lake Co.

21. PHRAGMIDIUM MONTIVAGUM Arth.

On *Rosa neomexicana* Cockerell: 2617, June 28, 1920, Bullion Canyon, near Marysville, Piute Co. 2759a, Aug. 23, 1920, Mendon, Cache Co. 2774, Sept. 18, 1920, Parley's Canyon, opposite refreshment stand.

On *Rosa puberulenta* Rydb.: 2651, July 19, 1920, Coal Creek branch, Cedar Canyon, Iron Co. 2720, August 3, 1920, Beaver Canyon, Beaver Co.

All of the above roses were determined by Dr. Rydberg.

25. PUCCINIA CLEMATIDIS (DC.) Lagerh.

On *Elymus condensatus* Presl.: 2512, July 18, 1919, Price, Carbon Co. Determined by Dr. Arthur.

On *Poa Fendleriana* (Steud.) Vasey: 2673, II, Wiley Camp, Zion National Park, Washington Co.

On *Ranunculus Cymbalaria* Pursh.: 2613a, I, June 28, 1920, Marysville, Piute Co.

On *Sitanion Hystrix* (Nutt.) J. G. Smith: 2710, ii, Aug. 3, 1920, Beaver Canyon, near Beaver, Beaver Co.

On *Sitanion jubatum* Smith: 2671, ii, July 22, 1920, Zion National Park, near Wiley Camp, Washington Co. The near-by *Clematis ligusticifolia* bore aecia.

32. PUCCINIA URTICAE (Schum.) Lagerh.

P. caricis (Schum.) Schröt.

On *Carex nebraskensis* Dewey: 2577, Oct. 11, 1919, Riverton, Salt Lake Co.

55. PUCCINIA GRAMINIS Pers.

On *Elymus Macounii* Vasey: 2576, Oct. 11, 1919, Riverton, Salt Lake Co. Host determined by Mrs. Agnes Chase; rust by Dr. Arthur.

On *Triticum vulgare* L.: 2719, II, Aug. 3, 1920, Beaver, Beaver Co. Rust determined by Dr. Arthur.

59. PUCCINIA HELIANTHI Schw.

On *Helianthus annuus* A. Gray: 2675, July 22, 1920, Zion's Canyon, Washington Co.

63. PUCCINIA HIERACII (Schum.) Mart.

On *Hieracium griseum* Rydb.: 2636, July 15, 1920, Gogorza, Summit Co.

69. PUCCINIA JONESII Peck

On *Cogswellia* sp.: 2650, July 17, 1920, Maple Canyon branch of Cedar Canyon, Iron Co. 2702, July 29, 1920, Parowan Main Canyon, Iron Co. The host in both collections was too old for determination, but is not one of the species previously reported as a Utah host for *P. Jonesii*.

76. PUCCINIA MENTHAE Pers. II

On *Mentha spicata* L.: 2692, July 28, 1920, Cedar City, Iron Co. 2756, August 20, 1920, Providence, Cache Co. 2757, August 20, 1920, Millville, Cache Co. Not before reported on this host for Utah.

79. PUCCINIA MONTANENSIS Ellis

On *Agropyron tenerum* Vasey: 2519, II, July 22, 1919, Orangeville, Emery Co. Determined by Dr. Arthur.

On *Elymus canadensis* L.: 2517, II, July 22, 1919, Orangeville, Emery Co. Determined by Dr. Arthur.

On *Hordeum jubatum* L.: 2518, II, July 22, 1919, Orangeville, Emery Co. Determined by Dr. Arthur.

78. PUCCINIA MONARDELLAE Dudley & Thompson II

On *Madronella oblongifolia* Rydb.: 2707, July 30, 1920, "Fish Lake Mtn.," Iron Co. Host determined by Dr. Rydberg; rust by Dr. Arthur.

85. PUCCINIA PATTERSONIANA Arth.

On *Agropyron spicatum* (Pursh) Scribn. & Smith: 2599, II, III, June 21, 1920, Gogorza, Summit Co. The only suspicious aecia found in the vicinity were those included in this list as *Uromyces Brodiaeae*. Although some of the aecia were quite old, no telia nor uredinia could be found.

On *Elymus condensatus* Presl.: 2770, II, III, Sept. 12, 1920, East Canyon, near Gogorza, Summit Co., not far from collections 2599. This was a heavy infection. The aecial host of this rust has never been determined.

96. PUCCINIA SHERARDIANA Körn.

P. Malvastris Peck.

On *Sphaeralcea pedata* Torr.: 2680, July 21, 1920, Zion's Canyon, Washington Co. Host determined by Dr. Rydberg.

On *Sphaeralcea arizonica* Heller: 2680a, July 23, 1920, Hurricane, Washington Co. Host determined by Dr. Rydberg.

On *Sphaeralcea dissecta* (Nutt.) Rydb.: 2712, Aug. 3, 1920, Beaver Canyon, Beaver Co. Host determined by Dr. Rydberg.

On *Sphaeralcea subrhomboidea* Rydb.: 2753, August 19, 1920, Logan, Cache Co. Host determined by Dr. Rydberg.

105. PUCCINIA SUBNITENS Dietel

On *Heliotropium spatulatum* Rydb. I, collected by E. M. Hall May 17, 1919, at St. George, Washington Co.

On *Tropaeolum* sp. cult. I, collected by E. M. Hall May 22, 1919, at St. George, Washington Co. This is the first collection ever made on this host.

On *Beta vulgaris* L. I, collected by E. M. Hall May, 1919, at St. George, Washington Co.

On *Atriplex rosea* L. (*A. spatiosa* A. Nels.) I, collected by E. M. Hall May 18, 1919, at St. George, Washington Co. I, collected by Ellsworth Bethel May 27, 1919, at Salt Lake City.

On *Lepidium perfoliatum* L. I, collected by Ellsworth Bethel May 27, 1919, at Salt Lake City. This is the first collection reported on this host.

On *Chenopodium album* L. I, collected by Ellsworth Bethel May 27, 1919, at Salt Lake City.

107. PUCCINIA SUBSTERILIS Ellis & Ev. X, iii

On *Stipa Lettermanni* Vasey: 2687, Coal Creek branch of Cedar Canyon, about fifteen miles from Cedar City, Iron Co. 2771, Sept. 12, 1920, East Canyon, Summit Co.

On *Oryzopsis hymenoides* (Roem. & Schult.) Ricker: 2670, July 22, 1920, Zion National Park, across river from Wiley Camp. The mesospores of this collection were in germinating condition.

114. PUCCINIA RUGOSA Billings, King's Report 40th Par. 914. 1871

P. Troximontis Pk.

On *Ptilocalais tenuifolia* Osterhout: 2596, June 21, 1920, Gogorza, Summit Co.

129. UROMYCES PUNCTATUS Schröt.

On *Kentrophyta impensa* (Sheld.) Rydb.: 2647, July 17, 1920, Maple Canyon branch of Cedar Canyon, Iron Co. Host determined by Dr. Rydberg.

On *Astragalus* sp.: 2659, July 19, 1920, Coal Creek branch of Cedar Canyon, Iron Co. A small species of *Astragalus*, not previously included in this list.

On *Astragalus humistratus* A. Gray: 2660, July 19, 1920, Cedar Canyon, Iron Co. Host determined by Dr. Rydberg.

On *Astragalus Sonorae* A. Gray: 2660a, July 19, 1920, Cedar Canyon. Host determined by Dr. Rydberg.

131. UROMYCES INTRICATUS Cooke

Uromyces Eriogoni Ellis & Harkn.

Two collections were made, each on a different species of *Eriogonum*, and each new to the species hitherto recorded in this list. Both hosts were too young, however, for specific determination. One collection was made in Maple Canyon, Iron Co., and the other in Zion Canyon, Washington Co.

132. UROMYCES PROEMINENS (DC.) Pass.

U. Euphorbiae Cooke & Peck.

On *Chamaesyce Greenei* (Millsp.) Rydb.: 2646a, July 18, 1920, Cedar City, Iron Co. 2509, July 18, 1919, Price, Carbon Co.

On *Chamaesyce rugulosa* (Engelm.) Rydb.: 2708, Aug. 3, 1920, Beaver Canyon, Beaver Co. The host of each of these collections was determined by Dr. Rydberg.

148. COLEOSPORIUM RIBICOLA (C. & E.) Arth. II

On *Ribes cereum* Dougl.: 2638, July 17, 1920, Maple Canyon, branch of Cedar Canyon, Iron Co. 2705, July 30, 1920, First Left-hand Fork Parowan Canyon, Iron Co. 2716, August 4, 1920, Beaver Canyon, Beaver Co. The host of these collections is considered to be the same as *R. inebrians* Lindl.

149. CRONARTIUM FILAMENTOSUM (Peck) Hedge. & Long I

Peridermium filamentosum Peck.

On *Pinus ponderosa scopulorum* Engelm.: 2628, July 1, 1920, extending southward from the south edge of Bryce Canyon, Garfield Co. This is the first record of the collection of this *Peridermium* in Utah. The *Peridermium* at this location is abundant, and is doing considerable damage to the pine trees.

150. CRONARTIUM PYRIFORME (Peck) Hedge. & Long I

Peridermium pyriforme Peck.

Cronartium Comandrae Peck.

On *Pinus ponderosa scopulorum* Engelm. Collected by Vernon Christensen (a former student in botany at the East High School, Salt Lake City), July 15, 1920, headwaters Provo River, Wasatch Co. This is the first collection of this *Peridermium* in Utah, although the *Cronartium* has previously been reported from several localities.

152. GYMNOSPORANGIUM GRACILENS (Peck) Kern & Bethel I

On *Philadelphus occidentalis* A. Nelson: 2669, July 22, 1920, Zion Canyon, Washington Co. Host determined by Dr. Rydberg. This extends the distribution of this *Gymnosporangium* about two hundred miles westward.

153. GYMNOSPORANGIUM INCONSPICUUM Kern

On *Juniperus utahensis* (Engelm.) Lemmon: 2641, July 17, 1920, Maple Canyon branch of Cedar Canyon, about five miles from Cedar City, Iron Co. The entire tree was covered with brown smears at and near the tips of the branchlets. 2700, July 29, 1920, Parowan Main Canyon, opposite Second Left-hand Fork. The branchlets covered with this rust (both in this collection, and No. 2641 above) seemed to be dead or dying.

On *Amelanchier utahensis* Koehne: 2643, I, July 16, 1920, Maple Canyon branch Cedar Canyon, about five miles from Cedar City, Iron Co. The infection was so heavy on the Amelanchiers of the region that scarcely a fruit could be found not affected by the rust. 2674, July 22, 1920, Zion National Park, near Wiley Camp, Washington Co. All of the fruits of all of the trees in the canyon seemed to be affected. 2704a, July 30, 1920, First Left-hand could be found not affected by the rust. 2674, July 22, 1920, Zion National Fork Parowan Canyon, near Parowan, Iron Co. 2725, I, Aug. 7, 1920, Fillmore, Millard Co. The peridia are beautifully developed in this collection. Rust determined by Dr. Arthur.

On *Amelanchier prunifolia* Greene: 2669a, I, July 22, 1920, Zion National Park, above Wiley Camp, Washington Co.

On *Amelanchier Jonesiana* C. K. Schneider: 2701, I, July 29, 1920, Parowan Main Canyon, near Parowan, Iron Co. Host determined tentatively by Dr. Rydberg.

All of the above aecial forms are on the fruit.

The canyons of southwestern Utah are surely a paradise for the collector of the Gymnosperms. Indeed, they are present in such profusion, and on such a variety of hosts, as to offer a very considerable puzzle to the collector who attempts to keep the species separated.

154 MELAMPSORA ALBERTENSIS Arth. I

Caeoma occidentalis Arth.

On *Pseudotsuga mucronata* (Raf.) Sudw.: 2685, July 27, 1920, Coal Creek Canyon branch of Cedar Canyon, about fourteen miles from Cedar City, Iron Co. This is the first recorded collection of this *Caeoma* for Utah, although the *Melampsora* on *Populus tremuloides* has been reported from San Juan Co.

164. PUCCINIA GRINDELIAE Peck

On *Chrysopsis horrida* Rydb.?: 2676, July 22, 1920, Zion Canyon, Washington Co.

181. UROMYCES OBLONGUS Vize

Three collections of this rust were made: 2679, July 22, 1920, Zion Canyon, Washington Co.; on *Trifolium Kingii* S. Wats.: 2686, July 27, Coal Creek branch Cedar Canyon, Iron Co.; and 2706, July 30, 1920, First Left-hand Fork Parowan Canyon, Iron Co. The rust was abundant; but with the exception of No. 2686 the *Trifolium* plants were too old to be determined.

184. *AECIDIUM ALLENII* Clinton

On *Shepherdia canadensis* Nutt.: 2686ab, July 27, 1920, Coal Creek Canyon branch of Cedar Canyon, Iron Co.

187. *CRONARTIUM OCCIDENTALE* Hedge., Bethel & Hunt

On *Pinus edulis* Engelm.: 2614a, June 27, 1920, mouth of Bullion Canyon, near Marysville, Piute Co. 2697, July 29, 1920, Parowan Main Canyon, Iron Co. A number of infections were on the tree from which this collection was made.

On *Ribes aureum* Pursh: 2696, July 29, 1920, Parowan Main Canyon, Iron Co. 2715, Aug. 3, 1920, Beaver, Beaver Co. 2724, Aug. 6, 1920, Hinckley, Millard Co. 2726, Aug. 7, 1920, Fillmore, Millard Co. 2730, Aug. 9, 1920, Holden, Millard Co. 2732, August 9, 1920, Scipio, Millard Co. 2738, August 13, 1920, Oak City, Millard Co. 2748, Aug. 20, 1920, Lewiston, Cache Co. 2751, Aug. 22, 1920, Hyrum, Cache Co. This was beautiful uredineal material. 2760, Aug. 23, II, III, Mendon, Cache Co. 2763, II, III, Aug. 24, 1920, Morgan, Morgan Co. The rust in III was also collected October 15, 1920, on bushes along Current Creek, in DuChesne County, a half-mile from the Wasatch County line by Miss Ruby Harkness, a former student in botany in the East High School, Salt Lake City. She reports that she found the *Cronartium* on the first bush examined.

On *Ribes cereum* Dougl.: 2714, August 3, 1920, Beaver Canyon, just below Upper Telluride Plant, about twelve miles from Beaver, Beaver Co. (This host is not considered sufficiently distinct from *R. inebrians* to warrant their separation.)

On *Grossularia leptantha* (A. Gray) Cov. & Britt.: 2713, Aug. 3, 1920, same locality as No. 2714 given immediately above. A small tree of *Pinus edulis* grew between the bushes. Not before reported for Utah on either of these last two hosts.

All of the above are new records for the distribution of the *Cronartium* and the *Peridermium*.

189. *GYMNOSPORANGIUM JUVENESCENS* Kern

On *Juniperus scopulorum* Sargent: 2642, III, July 19, 1920, Cedar Canyon near Cedar City, Iron Co. 2698a, July 29, 1920, Parowan Main Canyon near Parowan, Iron Co. 2640, July 17, 1920, Maple Canyon branch Cedar Canyon, about five miles from Cedar City, Iron Co. 2699, July 29, 1920, Parowan Main Canyon, near Parowan, Iron Co.

On *Amelanchier oreophila* A. Nels.: 2618, I, June 28, 1920, Bullion Canyon, near Marysville, Piute Co.

192. *PERIDERMIIUM COLORADENSE* (Dietel) Arthur & Kern

On *Picea Engelmanni* (Parry) Engelm.: 2661, July 9, 1920, Coal Creek branch Cedar Canyon, about fourteen miles from Cedar City. The aecia were just beginning to develop at this date. Many trees were affected.

203. *UROMYCES FUSCATUS* Arth.

On *Rumex paucifolius* Nutt.: 2636a, July 15, 1920, Gogorza, Summit Co. There has been some doubt in regard to the true identity of the host of this rust, the original description giving it as *Polygonum alpinum*. Several collections were made at this date from the same locality from which the original Utah collection was made June 29, 1915. The host plants were in bloom and young seed, and one plant was collected in flower with the broad lower leaves strongly infected by the rust. Unfortunately, this specimen has been mislaid. Host determined by Dr. Rydberg.

206*.² *GYMNOSPORANGIUM JUNIPERINUM* (L.) Mart. Fl. Crypt. Erlang. 333.
1817

On *Juniperus siberica* Burgsd.: 2615, June 28, 1920, Bullion Canyon, near Marysville, Piute Co. This is the first collection of this rust reported from Utah

207*. *PHRAGMIDIUM IMITANS* Arthur, N. A. Flora 7: 165. 1912

On *Rubus strigosus* Michx.: 2684, July 27, 1920, Coal Creek branch Cedar Canyon, about fourteen miles from Cedar City, Iron Co. The host was submitted to Dr. Rydberg for determination, and he writes: "It is none of the Rocky Mountain forms of red raspberry, but may be an escape of the eastern *R. strigosus*."

208*. *PUCCINIA APOCRYPTA* Ellis & Tracy

On *Agropyron tenerum* Vasey: 2663, II, III, July 19, 1920, Coal Creek branch Cedar Canyon, about fourteen miles from Cedar City, Iron Co. Host determined by Dr. Hitchcock; rust by Dr. Arthur.

209*. *PUCCINIA ANTIRRHINI* Diet. & Holw. Hedwigia 36: 298. 1897

On leaves and stems of *Antirrhinum majus* L.: 2507, July 12, 1919, Salt Lake City, Salt Lake Co. This destructive rust of greenhouse plants is altogether too widely spread in the greenhouses of Salt Lake and adjoining counties.

210*. *PUCCINIA MICRANTHA* D. Griff I. Bull. Torrey Club 29: 299. 1902

On *Grossularia leptantha* (A. Gray) Cov. & Britt.: 2717, Aug. 3, 1920, Beaver Canyon, just below Upper Telluride Plant, about fourteen miles from Beaver, Beaver Co. This collection moves the range of the species at least 200 miles westward.

211*. *PUCCINIA SUAVOLENS* (Pers.) Rostr. Forh. Skand. Nat. 11: 339. 1874

On leaves of *Cirsium arvense* (L.) Scop.: 2506, July 9, 1919, Provo, Utah Co. This collection extends the westerly range of this species by several hundred miles.

² Numbers followed with the asterisk (*) are those of species not included in any of the three preceding lists.

- 212*. *UROMYCES BRODIEAE* Ellis & Hark. l. Bull. Cal. Ac. Science 1884: 28.
1884

On *Brodiaea Douglasii* S. Wats.: 2507, June 21, 1920, Gogorza, Summit Co. The rust seemed to attack only the plants of the first year's growth. No plants in bloom could be found with the rust on them. No leaves with uredinea or telia could be found at this time, nor again on July 15. This leads to the suspicion that possibly we might have here the aecium of an unattached grass rust. As *P. Pattersoniana* occurred in abundance in the immediate vicinity, it was suspected of being the alternate form. This will at least bear investigation.

- 213*. *UROMYCES MEDICAGINIS* Pass. in Thüm. Herb. Myc. Oecon. 156. 1874

On leaves of *Medicago sativa* L.: 2766, Sept. 4, 1920, Salt Lake City. Not hitherto reported from Utah. Schroeter (Krypt. Fl. Schl. 3¹: 306. 1887) and Treboux (Ann. Myc. 10: 74. 1912) state that in Europe this rust has its aecial stage on various species of *Euphorbia*. The aecial stage has not yet been recognized as occurring in America.

EAST HIGH SCHOOL,

SALT LAKE CITY, UTAH.

THE BEHAVIOR OF TELIA OF PUCCINIA GRAMINIS IN THE SOUTH

H. R. ROSEN

Since July, 1918, the writer has had under observation the behavior of telia of *Puccinia graminis* Pers. on various grasses and the relationship of this spore stage to the overwintering and dissemination of the rust. It is well known that barberries, both native and introduced, are present in the southern states, and yet infections on this alternate host are apparently rare. Stakman (Separate from Yearbook of the United States Dept. of Agric. No. 796, 1918, p. 25) says, "There can be no question whatever that the barberry is the most important factor in the spread of rust in the northern half of the Mississippi basin. In the South it is less important." In a previous paper Rosen and Kirby (Phytopathology 9: 569-573. 1919, p. 571) record the absence in the Arthur Herbarium of aecial collections of *P. graminis* from the southern states. It was with the thought that a study of the behavior of telia might shed some light on the lack of barberry infections that these observations were undertaken at Fayetteville, Arkansas, latitude 36°. While the average temperatures prevailing at Fayetteville are lower than those in a major part of the state, the observations made in other sections indicate a close similarity in the behavior of stem rust.

As a rule black stem rust is not nearly as widespread or as destructive as the various leaf rusts. Occasionally, as in 1919, the wheat leaf rust, *Puccinia triticinia* Erikss., is so destructive that fields are abandoned and left unharvested, while the stem rust is only rarely observed. However, the stem rust of red top, *Agrostis palustris* Huds. (*A. alba* of authors) of timothy, *Phleum pratense* L., and of *Elymus australis* Scrib. and Ball is often prevalent. Perhaps it will be worth while to point out that the main difference between the urediniospores of the stem and leaf rusts is in the arrangement of the pores, being always equatorially disposed in the stem rust and always scattered in the leaf rusts. Such characters as color, shape, and size of the spores vary with

hosts, with degree of maturity and somewhat with environmental conditions. Racial differences are well known. The uredinia of stem rust have been studied, and dates kept of the earliest and latest appearance, but a discussion of this stage will be left for the future.

As compared to the uredinia, the telia of stem rust of the cereals are rare and underdeveloped in this state. At harvesting time, or indeed at any other time, while the uredinia may be readily found it usually takes careful searching to obtain telia. Moreover, examination of telia under the microscope shows spores which are considerably undersized and otherwise abnormal. In the fall of 1918, as well as in the fall of 1919, wheat straw containing telia, collected around Fayetteville, were put into wire cages and allowed to remain out of doors during the winter. No germination occurred, in contrast to the teliospores of over-wintered material of *Elymus australis* which germinated profusely as will be described. No explanation is at hand for this lack of normal telial development. It seems probable that the frequent and prolonged "dry spells" characteristic of the growing seasons of this section may have some influence on the development of telia. Possibly the time of wheat harvesting, usually in the first half of June, coming considerably earlier than in the sections where a profuse development of normal telia is common, as in the spring wheat section, may have something to do with it.

But while the cereal grasses ordinarily do not produce viable telial material the writer has carefully checked up the viability and infectivity of this stage on *Elymus australis*,¹ one of the common grasses of the region around Fayetteville. It is rather drought resistant, frequently to be seen making good growth when other grasses, both wild and cultivated, are either dead or suffering for want of moisture. During the fall of 1919 a very heavy infestation of the stem rust, in the form of telia, was noted in a good-sized patch of *Elymus* growing along a road side. The telia, unlike those observed on the cultivated cereals, appeared well developed, of a blackish color, and when examined under

¹ The writer is indebted to Mrs. Agnes Chase of the U. S. Department of Agriculture for the identification of this grass.

the microscope showed spores of a typically normal type in size, shape and color. The unique character of this telial material contrasting strongly with lack of telial development on other hosts and especially with material collected on the same day on timothy in which no telia but a very heavy infestation of uredinia was observed, made it appear worth while to study this *Elymus* infection. Several times during the fall, winter and early spring attempts were made to germinate the material collected on these different occasions but always without success. Profuse germination was finally obtained from material collected on April 5. This germinating material was smeared on young, moistened leaves of *Berberis trifoliolata* Moric., on a potted plant growing in the greenhouse, and the whole plant covered with a bell-jar for forty-eight hours. Another plant, uninoculated, served as a check. Reddish-yellow, cushion-like spots began to develop in about six days, and in eleven days, numerous pycnia, mostly epiphyllous, had developed. No infections developed on the check plant. The pycnia were typical of *Puccinia graminis* and the infections as a whole were similar to those obtained on the same host infected by using germinating telia on wheat straw coming from Iowa. (See Rosen and Kirby, loc. cit., p. 571.) It should be added that the telia were viable on April 29 and that on June 25 no germination was obtained. No data is at hand to indicate to which specialized race the telia of *Elymus australis* belong. Apparently this species of *Elymus* has not previously been recorded as a host for *P. graminis* and material has accordingly been deposited in the Arthur Herbarium. However, Stakman and Piemeisel (Jour. Agr. Res. 10: 429-495. 1917) list various species of *Elymus* as congenial hosts for two specialized races which attack wheat, the "biologic forms" *tritici* and *tritici compacti*, for the one which attacks rye, *secale*, and for the oat race, *avenae*, which appears only slightly infectious on *Elymus* spp.

The telia on *E. australis* here recorded are of interest not only because they differ from the ordinary behavior of stem rust telia in this region, but because they clearly show that if telia are fully developed they can be "overwintered" properly in this region and that they are infectious.

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NOTES AND BRIEF ARTICLES

[Unsigned notes are by the editor]

Readers of MYCOLOGIA are invited to contribute to this department personal news items and notes or brief articles of interest to mycologists in general. Manuscript should be submitted before the middle of the month preceding the month in which this publication is issued.

A new method of isolating single spores in Petri dishes for transfer is described by Carl D. LaRue in the *Botanical Gazette* for October, 1920.

Volume 7, parts 4 and 5, of *North American Flora*, by J. C. Arthur appeared at the close of 1920. They include descriptions of 201 species of *Dicoma*, of the Aecidiaceae. This important genus of plant rusts comprises, according to Dr. Arthur, a total of 269 species.

The dry-rot of incense cedar is discussed by J. S. Boyce in Bulletin 871 of the U. S. Department of Agriculture. The attacks of *Polyporus amarus* are very severe, owing to forest fires and various mechanical injuries. Trees with sporophores or serious wounds should be promptly cut. The rotation for incense cedar, according to the author, must not exceed 165 years in the intermediate and 210 years in the optimum range.

In his excellent paper on Crown-gall of Alfalfa, published in the *Botanical Gazette* for July, 1920, Mr. O. T. Wilson suggests that, although Magnus was right in removing the causative parasite from the genus *Cladochytrium*, it is doubtful whether he was justified in placing it in *Urophlyctis*. The author concludes with some interesting remarks about the Chytridiaceae in general and their relationship to the Myxomycetes.

In a short paper on Porto Rican fungi in the *Botanical Gazette*

for November, 1920, F. L. Stevens describes *Linospora trichostigmae*, on *Trichostigma octandra*; *Trabutia portoricensis*, on *Coccolobis nivea*; the genus *Trabutiella*, with *T. cordiae* as its type; *Hyponectria phaseoli*, on *Vigna vexillata*; and *Zythia phaseoli*, on *Phaseolus*. A fuller description is also given of *Anthostomella rhizomorphae* (Ktz.) B. & V., collected on *Rhizophora mangle*.

A Crop Protection Institute has been organized under the National Research Council to bring together the scientist, the grower, and the business man for mutual consultation regarding problems connected with the growing and marketing of crops. It proposes to cooperate with existing organizations wherever possible, and to undertake work that has hitherto been overlooked or imperfectly done. The control is in the hands of a Board of Trustees, two thirds of whom are scientists.

An abundantly illustrated article on the early development of *Inocybe*, by Gertrude E. Douglas, appeared in the *Botanical Gazette* for September, 1920. The lamellae develop as in most of the gill-fungi except those of the *Amanita* type. No marginal veil is formed, but the ground tissue on the outside of the pileus fundament becomes the blematogen, or universal veil. Several species of *Inocybe* were used for this study, the fresh plants in various stages being fixed in chromo-acetic acid of medium strength, then imbedded in paraffin, and stained with fuchsin after treatment with tannic acid.

An important paper on the development of *Cyathus* and *Crucibulum*, by Lena B. Walker, appeared in the *Botanical Gazette* for July, 1920. Six plates, with 70 excellent figures, greatly enhance the value of this paper. The three species used, *C. fascicularis*, *C. striatus*, and *C. vulgare*, grew readily on artificial media, but only the first produced mature fruit-bodies. The peridioles originate in all three species at given centers, toward which the ends of filaments converge. The most marked difference between *Crucibulum* and *Cyathus* is in the structure of the walls of the

peridia. In *Cyathus* a middle layer is present which is entirely wanting in *Crucibulum*.

Bulletin of the New York State Museum, Nos. 219, 220, appeared in January, 1920. It contains a reprint of the report of the state botanist for 1886, which has been so difficult to secure because so few copies were originally printed. A paper on fungi by Dr. House includes descriptions of *Mycena filopes* (Bull.) Quél. and *Mycena Atkinsoni* House, and the following new combinations: *Lophiotrema Peckiana* (Sacc.) House, *Helminthosporium pedunculatum* (Peck) House, *Gloniopsis Gloniopsis* (Gerard) House, and *Stereum Willeyi* (Clinton) Burt.

The first number of the *Bulletin of the Yama Farms Mycological Club* appeared in September, 1920. It contains a description of Yama Farms; the origin and purposes of the Club; plans for the future; a list of books and papers on the larger fungi; and a list of officers, including John Burroughs, W. A. Murrill, H. D. House, C. F. Millspaugh, G. T. Moore, William Trelease, H. I. Miller, C. H. Kauffman, Howard A. Kelly, Robert T. Morris, and others. The Club intends to make Yama Farms, a vast virgin tract in the southern Catskills, an important mycological center, with facilities for collecting and studying the fungi and other interesting forms of plant and animal life. Mrs. O. B. Sarre is permanent secretary-treasurer, and she was assisted during the season of 1920 by Miss Grace O. Winter, a graduate of Pennsylvania State College.

Enzyme action in *Echinodontium tinctorium*, one of the most destructive heart-rotting fungi on conifers in the West, was briefly discussed by Henry Schmitz in the *Journal of General Physiology* for July 20, 1920. The culture of the fungus used in this study was obtained from a young sporophore by the tissue method. The sporophore was carefully washed with sterile distilled water, dried by means of sterile tissue towelling, and cut open. Small portions of tissue were taken from the interior of the fruiting body and transferred to potato agar slants. After

the fungus had made considerable growth, transfers were made from the agar slants to sliced sterile carrots in large Erlenmeyer flasks, and the cultures incubated for 3 months at a temperature of 32° C. The fungus makes comparatively slow growth both on hard potato agar and on the carrots. While still in an actively growing condition the fungous mats were removed from the flasks, and, when thoroughly dry, were finely ground. The following enzymes were found to be present in the fungus: Esterase, maltase, lactase, sucrase, raffinase, diastase, inulase, cellulase, hemicellulase, urease, rennet, and catalase.

A handsome paper on the mosaic disease of cucurbits by S. P. Doolittle, has appeared as Bulletin 879 of the U. S. Department of Agriculture. According to the author, this disease has apparently been present in the United States for nearly 20 years, but prior to 1914 its importance was practically unrecognized. It appears both in the field and in the greenhouse in nearly all sections where cucurbits are of commercial importance. Nearly all cultivated cucurbits are susceptible to it, but the cucumber crop seems to be most seriously affected, particularly in the Central States and the trucking regions of the South. The diseased plants develop a yellow mottling of the younger leaves, accompanied by a wrinkled or savoyed appearance. The older leaves gradually turn yellow and die, leaving the basal portion of the stem bare.

No visible causal organism has been associated with cucurbit mosaic, and the disease appears to be unrelated to soil conditions. The juice of mosaic plants contains an infective principle, or virus, however, which possesses certain definite properties. The expressed juice of mosaic plants is rendered non-infectious if heated above 70° C. The power of infection is also destroyed by formaldehyde, phenol, and copper sulphate in 0.5 per cent solutions and by mercuric chlorid in a strength of 1:2,000. A 10 per cent solution of chloroform will also render the virus inactive, but neither 5 per cent chloroform nor 10 per cent toluene are effective.

The juice of mosaic diseased plants may be diluted to 1:10,000

and still retain the power of infection. The expressed juice of mosaic plants rarely remains infectious longer than 24 to 48 hours, and the virus is rapidly destroyed by desiccation. The infective principle, as far as it has been determined, possesses many properties of a living organism, and it appears possible that the disease may be caused by an ultramicroscopic parasite. The mosaic is highly infectious and can be produced by introducing the expressed juices or crushed tissues* of a mosaic plant into slight wounds in healthy plants.

VOLUME 10 OF NORTH AMERICAN FLORA

The first three parts of this volume were issued some time ago. The manuscript for part 4, prepared by Kauffman and Overholts, will be ready for the printer within a few months. Part 5 will be chiefly devoted to *Cortinarius*, to be treated by Kauffman. Part 6 will continue the brown-spored and black-spored agarics; and part 7, the gasteromycetes and an index, concluding the volume.

Specimens of gill-fungi with brown or black spores, or any of the gasteromycetes, will be very gladly received from mycological friends. I do not care for *Poria* at present; this group will have to wait until volume 8, containing the Thelephoraceae, Clavariaceae, Hydnaceae, etc., is well started.

The determination of miscellaneous collections of the higher fungi must take second place with me henceforth, as my time for scientific work is limited. I have enjoyed this kind of work immensely during the past twenty years, and a vast number of interesting things have been added to the herbarium through collections sent in from widely separated localities.

If collectors wish to deposit sets of their larger fungi here without expecting reports until the various groups are worked, such specimens will be welcomed. In the case of special plants sent in for critical examination, please mention the species with which you would have them compared and also give microscopic characters, so as to facilitate comparison as much as possible.

W. A. MURRILL

Supervisor of Public Instruction

TWO SPECIES OF FUSCOPORIA

1. *Fuscoporia tenerrima* (Berk. & Rav.) comb. nov.

Polyporus tenerrimus Berk. & Rav.; Berk. Grevillea 1: 65. 1872.
Poria tenerrima Cooke, Grevillea 14: 115. 1886.

Described as below from Ravenel's Carolina collections on the bark of *Ulmus americana*, and known only from that region and on that particular host. It is rather difficult to decide where it belongs without seeing fresh, well-developed specimens, but its affinities appear to be with *Fuscoporia*.

"Entirely resupinate; very thin and tender, of a watery texture, tawny; pores very small, confluent, with very thin dissepiments."

Ellis, N. Am. Fungi 922; Rav. Fungi Am. 710; Rav. Fungi Car. 3: 13.

2. *Fuscoporia nebulosa* (Berk. & Curt.) comb. nov.

Polyporus nebulosus Berk. & Curt. Jour. Linn. Soc. 10: 317. 1868.

Poria nebulosa Cooke, Grevillea 14: 115. 1886.

Described as below from Wright's collections on dead wood in Cuba. Known only from one collection. The entire plant, including the tubes, is very thin and delicate. It apparently belongs in *Fuscoporia*, but I have not been able to examine it microscopically.

"Subiculo tenuissimo pulveraceo ferrugineo; hymenio fusco, poris parvis brevissimis angulatis, dissepimentis tenuibus rigidis integris."

W. A. MURRILL

A DOUBLE MUSHROOM

A peculiar specimen of the ordinary cultivated mushroom, *Agaricus campester*, was sent me last October from the Hupfel-Carrar Mushroom Plantation in the Bronx, with the following note:

"We are herewith sending you, under separate cover, a freak of nature in the form of a mushroom picked from our mushroom

cellars, which we thought would interest you. As you see, the stem grew right through the top of the same. This is the first occurrence we have had of this kind although we have picked hundreds of thousands of mushrooms since we started our cellar."

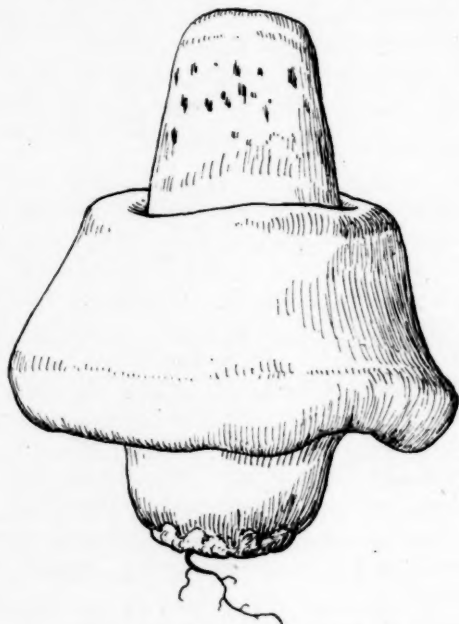


FIG. 1. Double mushroom, natural size

The accompanying sketches, reproduced natural size, was made by Miss Eaton from the fresh specimen. As may be seen in the section, there are two sets of gills, as well as two stems, as though the caps of two mushrooms occurring side by side had entirely grown together and the stronger mushroom had lifted the other into the air.

It is interesting to recall in this connection a figure, here reproduced, and a note that appeared in *Hardwicke's Science Gossip*, p. 209, 1866, which reads as follows:

"A TRIPLE MUSHROOM.—A physician of my acquaintance has a mushroom-bed in his cellar. A few weeks ago he cut one which was about five inches in

breadth, leaving the lower portion of the stem projecting from the bed. This afternoon he was surprised to find a peculiar double mushroom on the spot. It is formed of two mushrooms attached by their upper surfaces; the smaller one being placed in the inverted position on the upper one, and the cuticle of the two being continuous. The stem of the upper one was continuous with that of the large one which was cut off. The annexed sketch will give some idea of the nature of this curious monstrosity. The part above the dotted line represents the one cut off a few weeks ago; the part below is the double mushroom at present in my possession.—C. A."

While my attention was fixed on interesting morphological peculiarities like the above, a package of *Hypolysus Montagnei*, recently collected in Trinidad by Mrs. Britton, Miss Coker, and

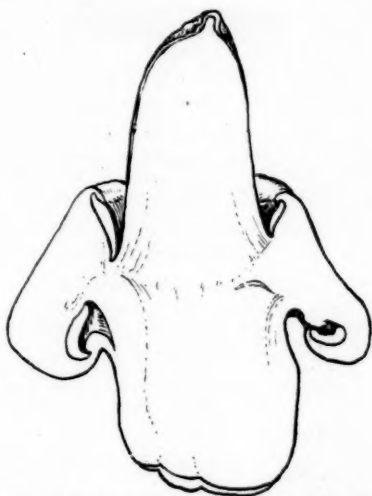


FIG. 2. Double mushroom in section, natural size

Mr. Rowland, was handed me for determination and I found that many of the small, goblet-shaped hymenophores had budded at the margin and produced from one to three secondary hymenophores with stalks and caps similar to the primary ones both in shape and size.

One frequently sees "buds" on the pilei of gill-fungi, usually bearing lamellae on their upper surface, but no trace of a stipe is ever present. In a pretty little specimen of *Marasmius col-*

lected last fall by Mr. George T. Hastings, a prominent "bud" had developed just at the apex of the pileus, looking as though the stipe had been prolonged and developed into a small, inverted, sessile pileus with lamellae similar to those of the normal



FIG. 3. Triple mushroom

pileus. The "buds," however, usually develop nearer the margin, those at the apex being very rare.

W. A. MURRILL

THE GENUS *TINCTOPORIA*

This genus was described in *North American Flora*, with *T. aurantiotingens* as its type. Two other interesting species belong here, one staining the substratum and the other not.

Hymenophore staining the substratum red.

Hymenium black.

1. *T. albocincta*.

Hymenium rosy-isabelline.

2. *T. graphica*.

Hymenophore not staining the substratum; hymenium black.

3. *T. Fuligo*.

1. *Tinctoporia albocincta* (Cooke & Massee) comb. nov.

Poria albocincta Cooke & Massee; Cooke, Grevillea 20: 106. 1892.

Poria Fuligo aurantiotingens Ellis & Macbr. Bull. Lab. Nat. Hist. Univ. Iowa 3²: 191. 1896.

Tinctoporia aurantiotingens (Ellis & Macbr.) Murrill, N. Am. Fl. 9: 14. 1907.

This species was studied by me in 1907, but several collections

have come in since that time, and I have discovered at Kew that another specific name has priority over the one I then used. This is *Poria albocincta*, described as follows from specimens collected on bark on the Island of St. Vincent:

"Tota resupinata, atro-cinerea, demum fissurato fatiscens; margine lato, niveo, pulverulento, tenui; tubulis circa 1 mm. longis, poris minutissimis, inconspicuis. Sporulis ellipticis, $4 \times 2 \mu$."

The only host mentioned in the new collections is *Ilex lucida*. Additional collections are:

Mexico, *Murrill 224*; Porto Rico, *Earle 116*, *Stevenson & Johnston 1482*; Guadeloupe, *Duss 574, 906*.

2. *Tinctoporia graphica* (Bres.) comb. nov.

Poria graphica Bres. *Hedwigia* 35: 282. 1896.

Collected on dead sticks in Brazil by Möller and described as below. A portion of the type is in the Garden herbarium.

"Late effusa tenuissima, lilacino-carnea, margine rubello, subiculo nullo; tubulis vix $\frac{1}{4}$ mm. longis; poris elongatis, sinuosis, variis, dissepimentibus tenuissimis praeditis; sporae non visae. Hyphae subhymeniales 3μ latae."

3. *Tinctoporia Fuligo* (Berk. & Br.) comb. nov.

Polyporus Fuligo Berk. & Br. *Jour. Linn. Soc.* 14: 53. 1875.

Polyporus Ravenalae Berk. & Br. *Jour. Linn. Soc.* 14: 53. 1875.

Polyporus Büttneri P. Henn. *Verh. Bot. Ver. Proc. Brand.* 30: 129. 1888.

Poria glauca Pat. *Jour. de Bot.* 5: 312. 1891.

Originally described from Peradenya, Ceylon, and several times collected in the Orient. *P. glauca* was described from Tonkin and *P. Büttneri* from Cameroon, Africa. This species is thin, annual, black, with a glaucous bloom in young stages, and does not stain the substratum red.

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NOTES ON A FEW PAPERS READ AT CHICAGO

Among the many interesting papers presented at the twelfth annual meeting of the American Phytopathological Society held

at Chicago, December 28-31, 1920, the following may be briefly mentioned:

"The regional occurrence of *Puccinia graminis* on barberry," by E. C. Stakman, R. S. Kirby, and A. F. Thiel.

The common barberry does not rust in the Southern States and on the Pacific Coast. It was found that barberries would not become infected in the Southern States when they were inoculated with teliospore material which had been developed in the South; but when inoculated with teliospores from the North, they became very heavily infected. Excellent infection was obtained as early as March 16 by using northern material. Teliospores from the South which had been kept in the North during the summer and fall, however, caused infection in the South, while northern teliospores which had been kept in the South did not cause infection. Teliospores formed in the fall in the South caused infection in the following spring. Evidently, therefore, the reason why barberries do not become infected in the South is not because conditions are unfavorable for infection, but because practically no teliospores are viable in the spring.

"The effect of incipient decay on the mechanical properties of airplane timber," by Reginald H. Colley.

Standard tests conducted at the University of California by the Bureau of Plant Industry in cooperation with the Forest Service indicate marked differences in the effect of different fungi on the mechanical properties of airplane timber. Pieces of Sitka spruce and Douglas fir showing incipient decay were tested against matched sound pieces. The effect of *Fomes pinicola*, *Fomes laricis*, and *Polyporus schweinitzii*, which may be grouped together, was decidedly more marked than that of *Trametes pini*. Test sticks taken many feet ahead of the typical rot showed the weakening effect of *P. schweinitzii*, while sticks infected with *T. pini* gave as high or higher results than sound wood. Lumbermen have long recognized that wood infected with *T. pini* is strong even in the early pocket stage. Results point to need for more careful inspection and diagnosis of incipient decay in forest and mill to prevent the expense of working and finishing defective stock and its inclusion in the airplane.

"Valsa poplar canker," by Alfred H. W. Povah.

This disease, under the name *Cytospora chrysosperma* (Pers.) Fr. has been reported from the Southwest by Long and from the Northwest by Hubert. It has been found near Syracuse, New York, to cause serious injury and in some cases death to *Populus tremuloides* and *P. grandidentata* when weakened by fire. Field studies show infection of 68.4 per cent and mortality of 36.9 per cent. The perfect stage (*Valsa* sp.) has been found on the trunks of infected trees. Inoculation experiments with pycnosporos on cuttings of *P. tremuloides*, *P. grandidentata*, and *P. caroliniana* have resulted in the production of typical pycnia, bearing the characteristic red spore horns, and the death of the cuttings. Cuttings not inoculated but kept in the laboratory where material bearing spore horns was exposed soon became infected and were killed.

"Lightning injury to *Hevea brasiliensis*," by Carl D. La Rue.

Lightning injury to the Para rubber tree (*Hevea brasiliensis*) rarely manifests itself in tearing or breaking of the trunks or branches. Usually a single small branch at the top of the tree dies first. From this point the death of the branch continues downward until the trunk is reached, then the trunk dies back until the root is reached and finally the whole tree is killed. Several days may elapse from the time the injury is first visible until the whole tree is dead. The progressive death of the tissues is extremely suggestive of invasion of the tree by some destructive organism. The injury has been attributed to *Diplodia* and the supposedly guilty organism named *Diplodia rapax*. Cultures by the author showed *Diplodia* to be the only organism constantly present, but this is now known to be secondary and not the cause of the death of the tree. The injury is most pronounced in the cambium region. Here the tissue becomes deep-purple in color and decays with great rapidity, making it easy to trace the progress of the injury. The purple coloration is regarded by the author as diagnostic for this type of injury. Frequently, trees surrounding the dying tree show injury in lesser degree, which develops later than of the tree most seriously injured, thus suggesting the spread of an organism from one tree to the other.

"A dry rot of the sugar beet caused by *Corticium vagum*," by B. L. Richards.

A serious and apparently undescribed rot of the sugar beet has been observed during the past season in a number of beet fields in northern Utah and southern Idaho. The disease, as it appears in the field, is confined to somewhat definitely delimited areas wherein every beet may become infected. The roots of the diseased beets show circular lesions characterized by very prominent alternating light and dark brown concentric rings. The disease is typically a dry rot. In the later stages a deep pocket, partly filled with a dry pulp composed of mycelium and decayed host tissue, results at each point of infection. With numerous points of attack the beet by harvest time may be converted into a dry, pithy mass. Numerous isolations from sugar beets, taken from a number of fields, have given what, from cooperative studies, appears to be a single strain of *Corticium vagum* B. & C. Inoculation shows this strain to be extremely virulent, and lesions have been produced on normal healthy beets with unusual uniformity.

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